

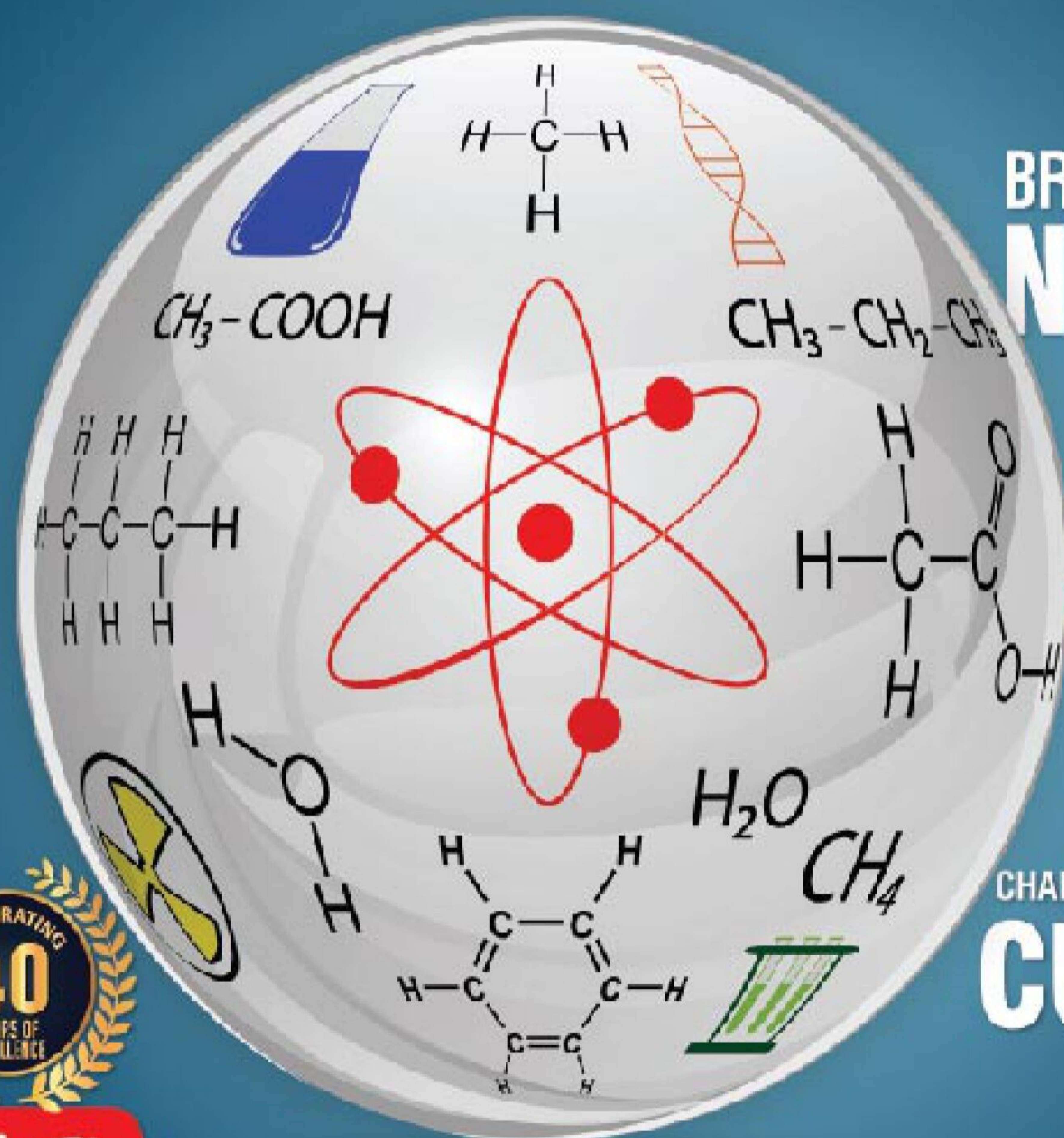
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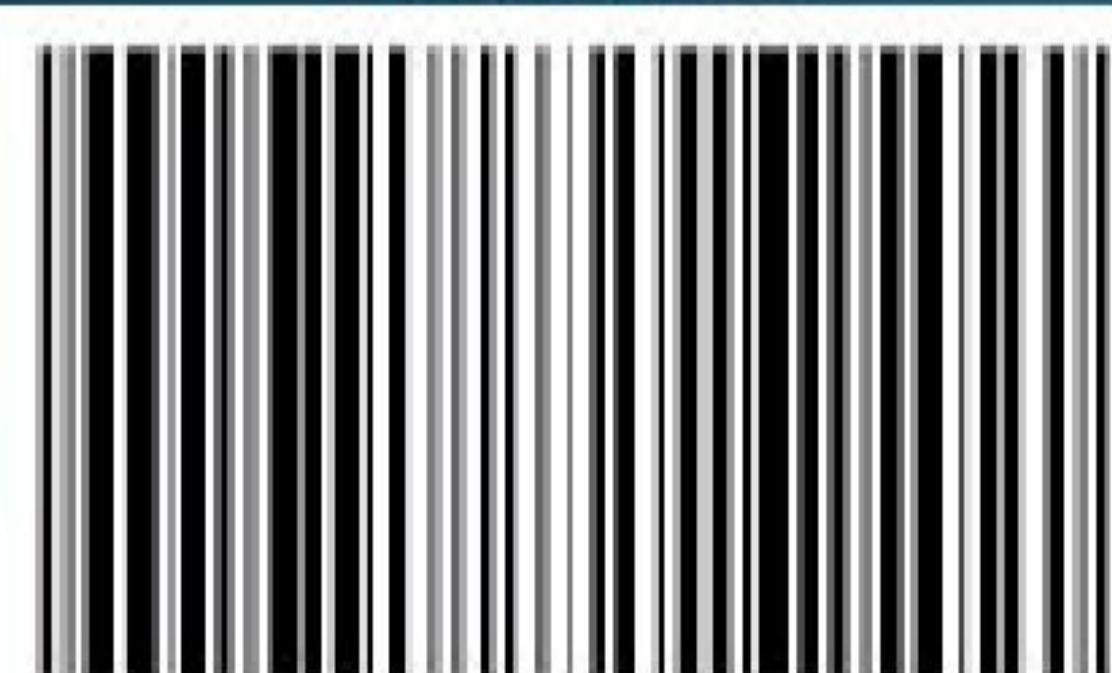
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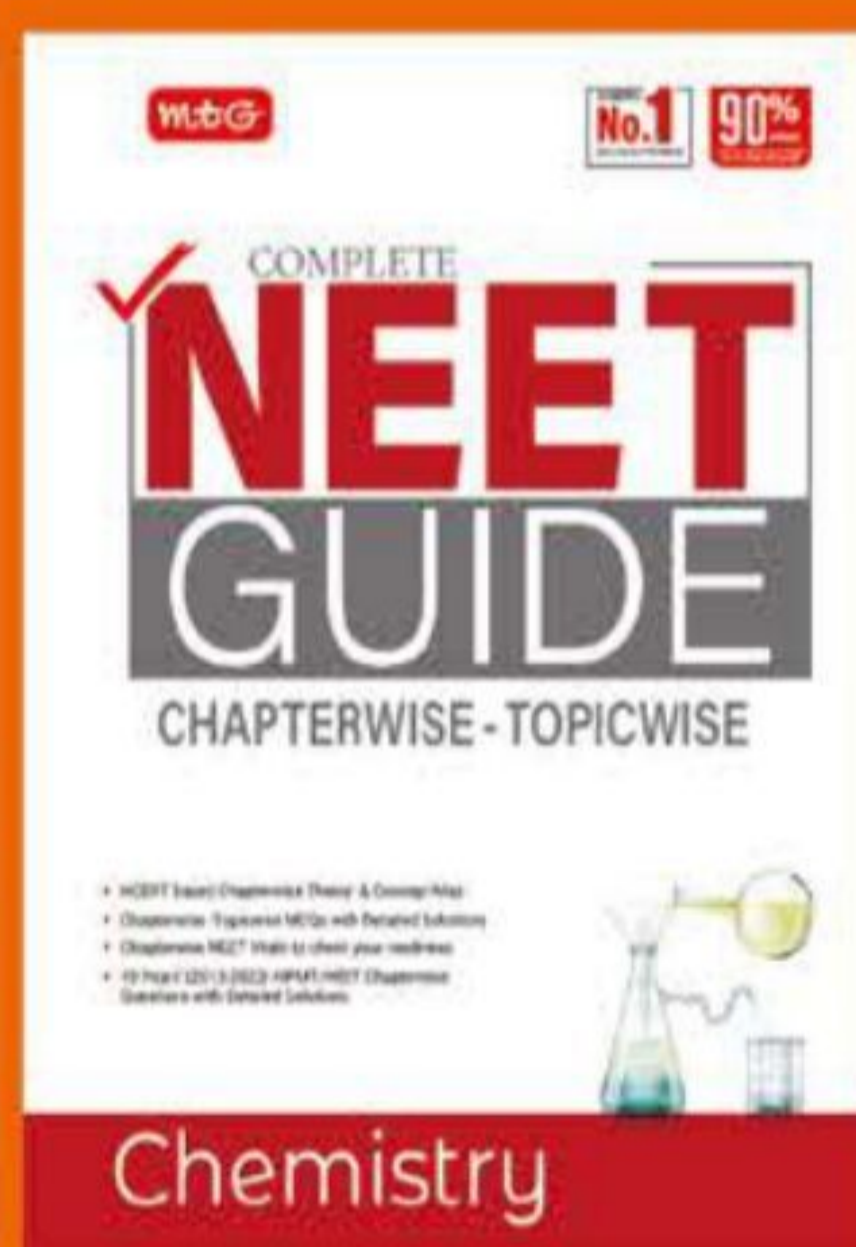
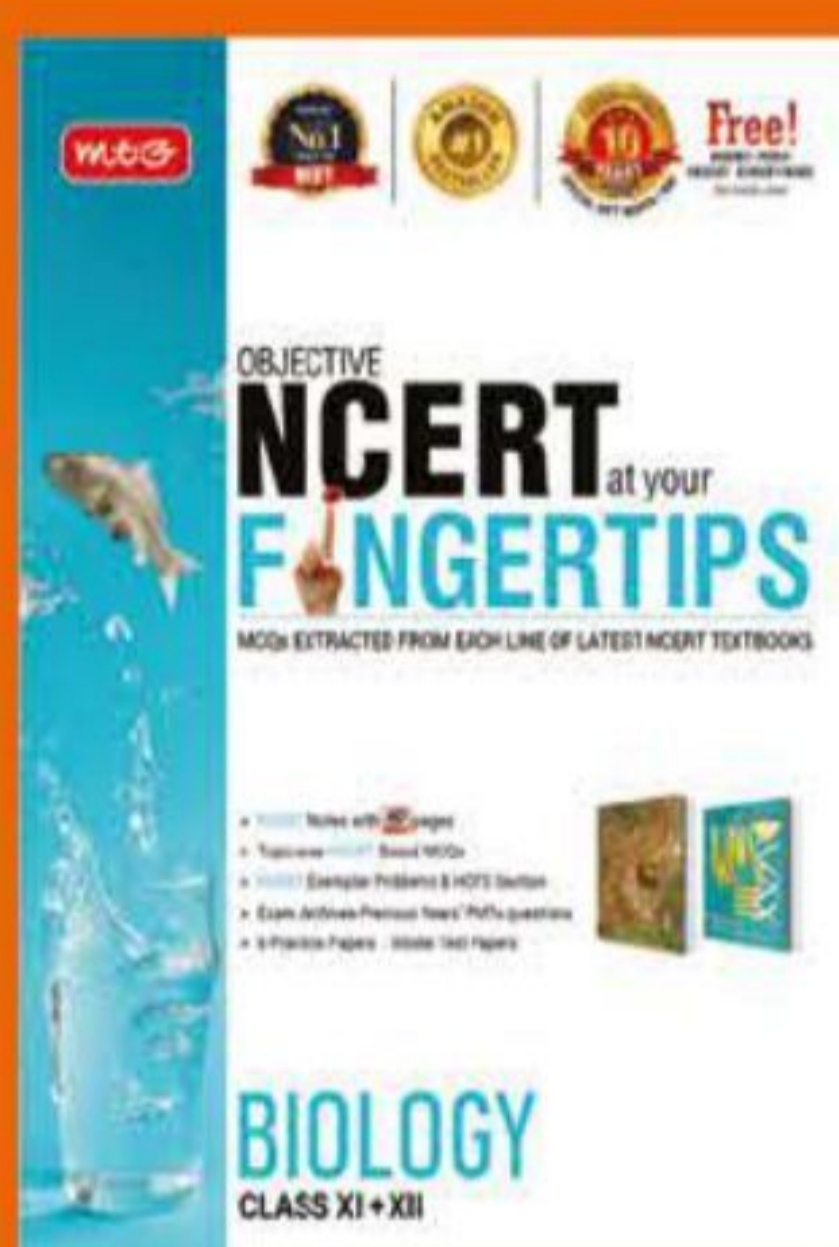
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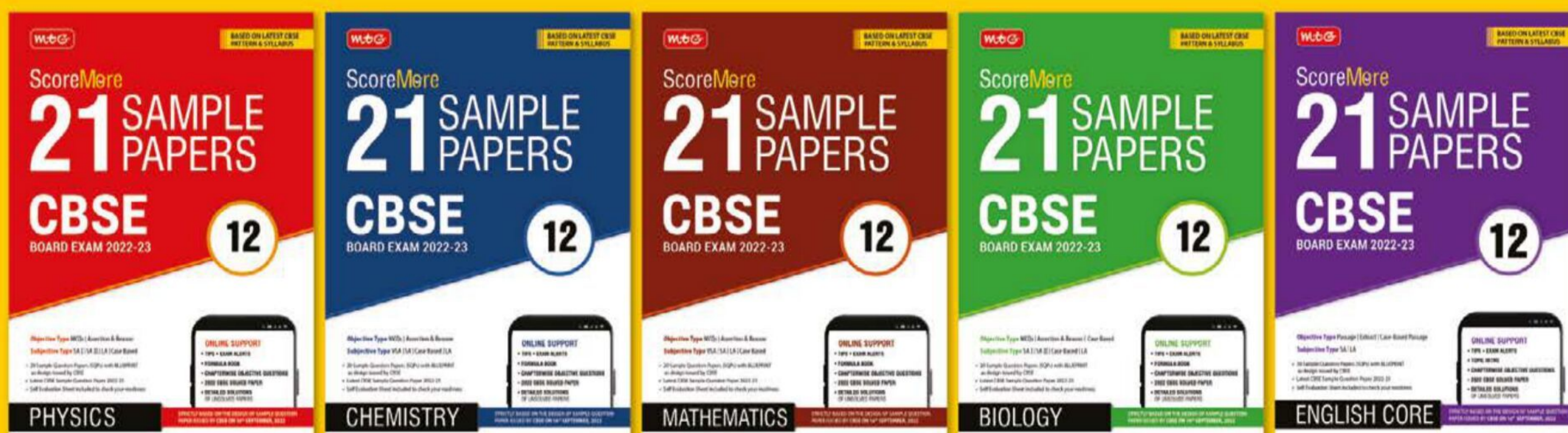
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Managing Editor
Mahabir Singh

Editor
Anil Ahlawat

Corporate Office:

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Tel : 0124-6601200 e-mail : info@mtg.in website : www.mtg.in

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The Nobel Prize in Chemistry 2022



Carolyn R. Bertozzi
Prize share: 1/3



Morten Meldal
Prize share: 1/3



K. Barry Sharpless
Prize share: 1/3

The Nobel Prize in Chemistry 2022 was awarded jointly to Carolyn R. Bertozzi, Morten Meldal and K. Barry Sharpless "for the development of click chemistry and bioorthogonal chemistry".

It just says click – and the molecules are coupled together

The Nobel Prize in Chemistry 2022 is about making difficult processes easier. Barry Sharpless and Morten Meldal have laid the foundation for a functional form of chemistry – Click Chemistry – in which molecular building blocks snap together quickly and efficiently. Carolyn Bertozzi has taken click chemistry to a new dimension and started utilising it in living organisms.

Chemists have long been driven by the desire to build increasingly complicated molecules. In pharmaceutical research, this has often involved artificially recreating natural molecules with medicinal properties. This has led to many admirable molecular constructions, but these are generally time consuming and very expensive to produce. "This year's Prize in Chemistry deals with not overcomplicating matters, instead working with what is easy and simple. Functional molecules can be built even by taking a straightforward route", says Johan Åqvist, Chair of the Nobel Committee for Chemistry.

Barry Sharpless – who is now being awarded his second Nobel Prize in Chemistry – started the ball rolling. Around the year 2000, he coined the concept of click chemistry, which is a form of simple and reliable chemistry, where reactions occur quickly and unwanted by-products are avoided.

Shortly afterwards, Morten Meldal and Barry Sharpless – independently of each other – presented what is now the crown jewel of click chemistry: the copper catalysed azide-alkyne cycloaddition. This is an elegant and efficient chemical reaction that is now in widespread use. Among many other uses, it is utilised in the development of pharmaceuticals, for mapping DNA and creating materials that are more fit for purpose.

Carolyn Bertozzi took click chemistry to a new level. To map important but elusive biomolecules on the surface of cells – glycans – she developed click reactions that work inside living organisms. Her bioorthogonal reactions take place without disrupting the normal chemistry of the cell.

These reactions are now used globally to explore cells and track biological processes. Using bioorthogonal reactions, researchers have improved the targeting of cancer pharmaceuticals, which are now being tested in clinical trials.

Click chemistry and bioorthogonal reactions have taken chemistry into the era of functionalism. This is bringing the greatest benefit to humankind.



CHAPTERWISE PRACTICE PAPER 2023

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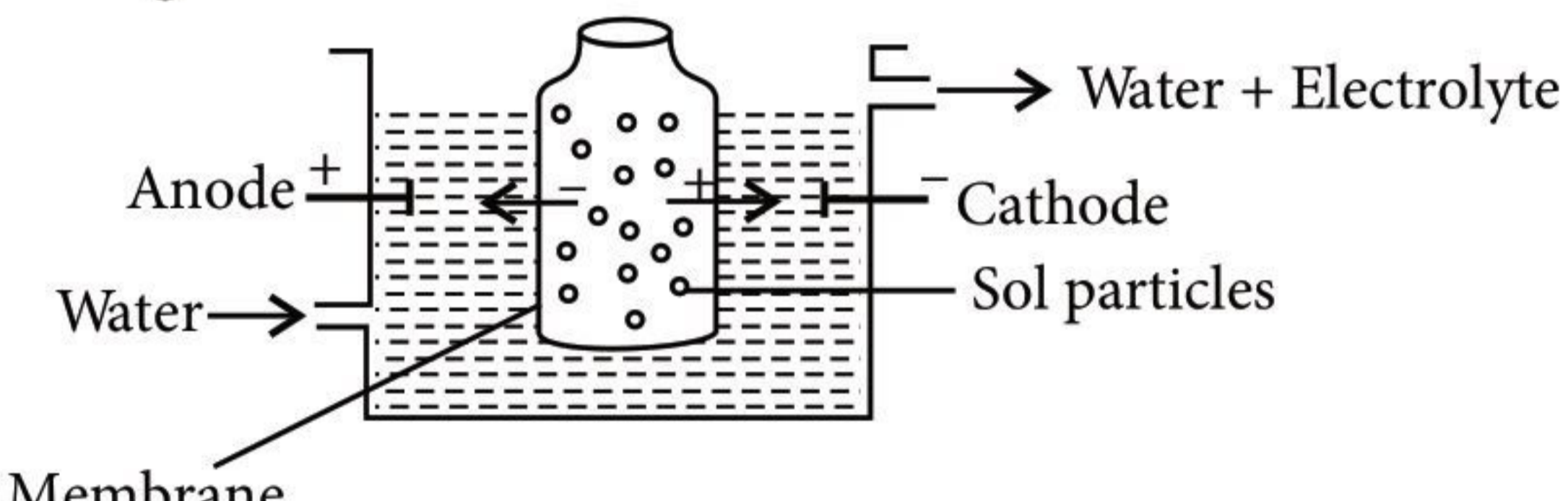
SERIES - III Surface Chemistry | General Principles and Processes of Isolation of Elements

Section II of CUET (UG) is domain specific. In this section of Chemistry 40 questions to be attempted out of 50.

Time Allowed : 45 Minutes

Maximum Marks : 200

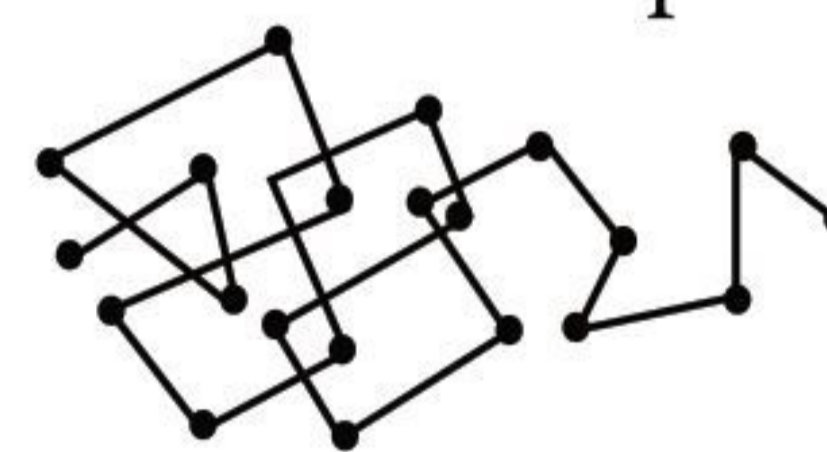
Multiple Choice Questions (MCQs)

- Which of the following statements is not correct about adsorption and absorption?
 - In adsorption, the substance is concentrated only at the surface while in absorption, it is uniformly distributed in the bulk.
 - Adsorption is instantaneous while absorption is a slow process.
 - A substance can be adsorbed as well as absorbed simultaneously and the process is called sorption.
 - Only gases are adsorbed while solids and liquids are absorbed.
- For Freundlich adsorption isotherm, a graph of $\log \frac{x}{m}$ is plotted against $\log p$. The slope of the line and its y -axis intercept, respectively corresponds to
 - $\frac{1}{n}, k$
 - $\log \frac{1}{n}, k$
 - $\frac{1}{n}, \log k$
 - $\log \frac{1}{n}, \log k$
- In a mixture of PbS, ZnS and FeS, each component is separated from other by using which of the following sequence of reagents in the froth floatation process?
 - Potassium ethyl xanthate, KCN
 - Potassium ethyl xanthate, KCN, NaOH, CuSO_4 , acid
 - KCN, CuSO_4 , acid
 - None of these
- Which of the following processes is being shown in the figure?
 
 - Electrodialysis
 - Dialysis
 - Electroosmosis
 - Electrophoresis
- Traces of molybdenum are used with finely divided iron which acts as a catalyst during Haber's process for synthesis of ammonia. The molybdenum
 - acts as a promoter to increase the activity of the catalyst
 - acts as a poison to decrease the activity of the catalyst
 - provides a new pathway to the reaction
 - forms another intermediate compound with lesser activation energy.
- $$\underset{\text{Impure}}{\text{Ni}} + 4\text{CO} \xrightarrow{60-80^\circ\text{C}} \text{Ni(CO)}_4 \xrightarrow{180^\circ\text{C}} \underset{\text{Pure}}{\text{Ni}} + 4\text{CO}$$
 The above process of purification of the metal is known as
 - van Arkel process
 - pyrometallurgy
 - mond process
 - zone refining.
- Following reactions take place during extraction of gold.

$$4\text{Au} + 8\text{CN}^- + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4[\text{Au(CN)}_2]^- + 4\text{OH}^-$$

$$2[\text{Au(CN)}_2]^- + \text{Zn} \rightarrow 2\text{Au} + [\text{Zn(CN)}_4]^{2-}$$
 Zinc in the extraction of gold acts as a/an
 - oxidising agent
 - flux
 - reducing agent
 - decomposing agent.
- Ellingham diagrams can be drawn for the
 - sulphides
 - oxides
 - halides
 - all of these.

9. During adsorption of a gas on a solid,
 (a) $\Delta G > 0, \Delta H > 0, \Delta S > 0$
 (b) $\Delta G < 0, \Delta H < 0, \Delta S > 0$
 (c) $\Delta G < 0, \Delta H > 0, \Delta S > 0$
 (d) $\Delta G < 0, \Delta H < 0, \Delta S < 0$
10. Which one of the following is not a property of physical adsorption?
 (a) It results into unimolecular layer.
 (b) Greater the surface area, more the adsorption.
 (c) Lower the temperature, more the adsorption.
 (d) No appreciable activation energy is required.
11. In the extraction of copper from its sulphide ore, metal is finally obtained by the oxidation of cuprous sulphide with
 (a) CO (b) Cu_2O (c) Fe_2O_3 (d) SO_2
12. Hydrogenation of vegetable oils occurs in the presence of finely divided nickel as catalyst, the reaction is
 (a) enzyme catalysed reaction
 (b) liquid catalysed reaction
 (c) heterogeneous catalysis
 (d) homogeneous catalysis.
13. Zeta potential is
 (a) potential required to bring about coagulation of a colloidal sol
 (b) potential required to give the particle a speed of 1 cm s^{-1}
 (c) potential difference between fixed charged layer and the diffused layer having opposite charges
 (d) potential energy of the colloidal particles.
14. Among the following, the ion which will be more effective for flocculation of $\text{Fe}(\text{OH})_3$ sol is
 (a) PO_4^{3-} (b) SO_4^{2-} (c) SO_3^{2-} (d) NO_3^-
15. Which one of the following is true for electrolytic refining?
 (a) Impure metal is made cathode.
 (b) Impure metal is made anode.
 (c) Impure metal is made cathode and pure metal as anode.
 (d) Both electrodes must be of pure metal.
16. Which one of the following ores is best concentrated by froth floatation method?
 (a) Magnetite (b) Siderite
 (c) Galena (d) Malachite
17. Calamine, malachite, magnetite and cryolite, respectively, are
 (a) $\text{ZnSO}_4, \text{Cu}(\text{OH})_2, \text{Fe}_3\text{O}_4, \text{Na}_3\text{AlF}_6$
 (b) $\text{ZnCO}_3, \text{CuCO}_3, \text{Fe}_2\text{O}_3, \text{Na}_3\text{AlF}_6$
 (c) $\text{ZnSO}_4, \text{CuCO}_3, \text{Fe}_2\text{O}_3, \text{AlF}_3$
 (d) $\text{ZnCO}_3, \text{CuCO}_3, \text{Cu}(\text{OH})_2, \text{Fe}_3\text{O}_4, \text{Na}_3\text{AlF}_6$
18. The metal extracted by leaching with cyanide is
 (a) Cu (b) Al (c) Na (d) Ag
19. Which of the following is not a characteristic of chemisorption?
 (a) Adsorption is specific.
 (b) Heat of adsorption is of the order of 200 kJ mol^{-1} .
 (c) Adsorption is irreversible.
 (d) Adsorption may be multimolecular layers.
20. The ore haematite is
 (a) Fe_3O_4 (b) Fe_2O_3
 (c) $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ (d) FeS_2
21. Which of the following statements is not correct for chemisorption and physisorption?
 (a) Physical adsorption occurs at a low temperature and chemisorption occurs at all temperatures.
 (b) Magnitude of chemisorption decreases with rise in temperature while physisorption increases with rise in temperature.
 (c) Chemisorption is irreversible and physisorption is reversible.
 (d) In physisorption, activation energy is low while in chemisorption, it is high.
22. The process of zone refining is used in the purification of
 (a) Al (b) Ge (c) Cu (d) Ag
23. Purification of aluminium by electrolytic refining is called
 (a) Hall's process
 (b) Froth floatation process
 (c) Baeyer's process
 (d) Hoopes process.
24. The cause of Brownian movement, which is not shown by true solutions or suspensions is due to
 (a) unbalanced bombardment of particles by molecules of the dispersion medium
 (b) attractive forces between dispersed phase and dispersion medium
 (c) larger size of the particles due to which they keep colliding and settling down
 (d) convection currents formed in the sol.





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25. A colloidal system in which liquid is dispersed phase and solid is dispersion medium is classified as
 (a) gel (b) sol
 (c) emulsion (d) aerosol.
26. Choose the process that involves smelting.
 (a) $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O} \xrightarrow{\text{Heat}} \text{Al}_2\text{O}_3 + 2\text{H}_2\text{O}$
 (b) $2\text{HgS} + 3\text{O}_2 \xrightarrow{\text{Heat}} 2\text{HgO} + 2\text{SO}_2$
 (c) $\text{Fe}_2\text{O}_3 + 3\text{C} \xrightarrow{\text{Heat}} 2\text{Fe} + 3\text{CO}$
 (d) $3\text{Cu}_2\text{S} + 3\text{O}_2 \xrightarrow{\text{Heat}} 6\text{Cu} + 3\text{SO}_2$
27. van Arkel method of refining zirconium involves
 (a) removing all oxygen and nitrogen impurities
 (b) removing CO impurity
 (c) removing hydrogen impurity
 (d) removing silica impurity.
28. Semiconductors of very high purity are obtained by
 (a) liquation (b) vapour phase refining
 (c) zone refining (d) electrolysis.
29. The critical micelle concentration (CMC) is defined as
 (a) the concentration at which micellization starts
 (b) the concentration at which micelle starts behaving like an electrolyte
 (c) the concentration at which dispersed phase is separated from dispersion medium
 (d) the concentration at which a colloid is converted to suspension.
30. Which of the following is an example of heterogeneous catalysis?
 (a) $4\text{NH}_3 + 5\text{O}_2 \xrightarrow{\text{Pt}} 4\text{NO} + 6\text{H}_2\text{O}$
 (b) $2\text{SO}_2 + \text{O}_2 \xrightarrow{\text{NO}} 2\text{SO}_3$
 (c) $\text{CH}_3\text{COOCH}_3 + \text{H}_2\text{O} \xrightarrow{\text{HCl}} \text{CH}_3\text{COOH} + \text{CH}_3\text{OH}$
 (d) $\text{C}_{12}\text{H}_{22}\text{O}_{11} + \text{H}_2\text{O} \xrightarrow{\text{H}_2\text{SO}_4} \text{C}_6\text{H}_{12}\text{O}_6 + \text{C}_6\text{H}_{12}\text{O}_6$
31. Which of the following reactions show the process of smelting?
 (a) $2\text{PbO} + \text{PbS} \rightarrow 3\text{Pb} + \text{SO}_2$
 (b) $2\text{Na}[\text{Au}(\text{CN})_2] + \text{Zn} \rightarrow \text{Na}_2[\text{Zn}(\text{CN})_4] + 2\text{Au}$
 (c) $\text{PbO} + \text{C} \rightarrow \text{Pb} + \text{CO}$
 (d) $2\text{HgS} + 3\text{O}_2 \rightarrow 2\text{HgO} + 2\text{SO}_2$
32. Which of the following is not a correct match?
 (a) Butter - O/W type emulsion
 (b) Vanishing cream - O/W type emulsion
 (c) Milk - O/W type emulsion
 (d) Cold cream - W/O type emulsion
33. Chromatography is a useful method for purification of elements which are

- (a) very reactive
 (b) available in minute quantities
 (c) present in abundance
 (d) highly electropositive.

34. _____ and _____ are alloys of copper.
 (a) Brass, bronze (b) Brass, alloy steel
 (c) Copper pyrites, malachite
 (d) Copper glance, cuprite

Assertion & Reason Based MCQs

For question numbers 35-38, a statement of Assertion followed by a statement of Reason is given. Choose the correct answer out of the following choices.

- (a) If both assertion and reason are correct and reason is the correct explanation of assertion.
 (b) If both assertion and reason are correct but reason is not the correct explanation of assertion.
 (c) If assertion is correct but reason is wrong.
 (d) If assertion is wrong but reason is correct.

35. **Assertion :** Minerals are naturally occurring chemical substances in the earth's crust obtainable by mining.

Reason : Minerals are also known as ores.

36. **Assertion :** Solids in finely divided state act as good adsorbents.

Reason : Adsorption is a surface phenomenon.

37. **Assertion :** Zone refining method is used to produce pure metals which are used as semiconductors.

Reason : Semiconductors are used in highly pure form.

38. **Assertion :** A colloidal sol scatters light but a true solution does not.

Reason : The particles in a colloidal sol are big enough to scatter the beam of light passing through it, thus making its path visible.

Match the Columns

39. Match the Column I and Column II and mark the appropriate choice.

Column I		Column II	
(A)	Diastase	(i)	Proteins \rightarrow Amino acids
(B)	Pepsin	(ii)	Glucose \rightarrow Ethyl alcohol
(C)	Ptyalin	(iii)	Starch \rightarrow Maltose
(D)	Zymase	(iv)	Starch \rightarrow Sugar

- (a) (A) \rightarrow (iv), (B) \rightarrow (ii), (C) \rightarrow (i), (D) \rightarrow (iii)
 (b) (A) \rightarrow (ii), (B) \rightarrow (i), (C) \rightarrow (iv), (D) \rightarrow (iii)
 (c) (A) \rightarrow (i), (B) \rightarrow (ii), (C) \rightarrow (iii), (D) \rightarrow (iv)
 (d) (A) \rightarrow (iii), (B) \rightarrow (i), (C) \rightarrow (iv), (D) \rightarrow (ii)

40. Match the Column I with Column II and mark the appropriate choice.

Column I		Column II	
(A)	Electrical industry	(i)	Zinc
(B)	Batteries	(ii)	Aluminium
(C)	Gutter pipes	(iii)	Copper
(D)	Chocolate wrappers	(iv)	Cast iron

- (a) (A) → (i), (B) → (ii), (C) → (iii), (D) → (iv)
 (b) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)
 (c) (A) → (iv), (B) → (iii), (C) → (ii), (D) → (i)
 (d) (A) → (iii), (B) → (i), (C) → (iv), (D) → (ii)

Case Based MCQs

Case I : Read the passage given below and answer the following questions from 41 to 45.

The heating process for the extraction of elements is quite old but highly acceptable method for the extraction of elements. Because in this process, the element produced is in the highly pure state. Mostly As, Sb, N₂, Ni, Zr, B, etc. are prepared by this principle.

A number of metal sulphides used, may be roasted first in air to partially convert them to the oxide and then further roasted in the absence of air, causing self reduction.

The following questions are multiple choice questions. Choose the most appropriate answer :

41. Heating pyrites to remove sulphur is called
 (a) smelting (b) calcination
 (c) liquation (d) roasting.
42. Which of the following is not an example of roasting?
 (a) $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$
 (b) $2\text{PbS} + 3\text{O}_2 \rightarrow 2\text{PbO} + 2\text{SO}_2$
 (c) $2\text{Cu}_2\text{S} + 3\text{O}_2 \rightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$
 (d) $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \rightarrow 6\text{Cu} + \text{SO}_2$
43. Which of the following sulphides when heated strongly in air gives the corresponding metal without undergoing separate reduction of oxide?
 (a) Cu₂S (b) FeS (c) HgS (d) ZnS
44. Which of the following changes take place during roasting?
 (i) Impurities are removed as their volatile oxides.
 (ii) Ore is converted into its oxide.
 (iii) Changes like oxidation, chlorination, etc. take place.
 (a) (i) and (ii) (b) (ii) and (iii)
 (c) (i) and (iii) (d) (i), (ii) and (iii)

45. Sulphides ores are converted to oxides before reduction. This is explained on the basis of the following:

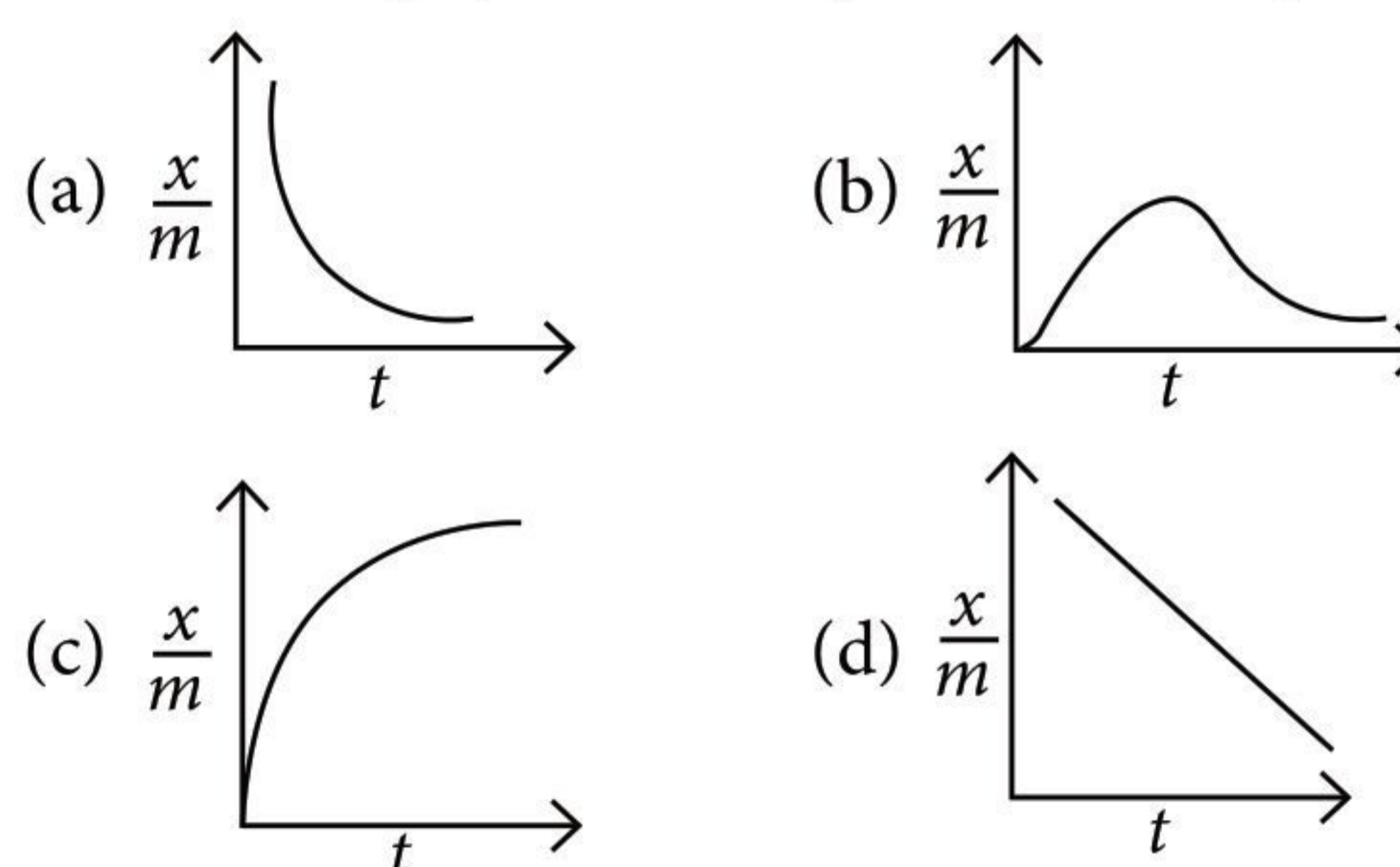
- (a) Sulphides cannot be reduced easily while oxides can be reduced easily.
 (b) Sulphides decompose on reduction hence, they are first converted to oxides.
 (c) Sulphide ores have higher melting points than oxides.
 (d) Oxides are more stable than sulphides hence, easy to reduce.

Case II : Read the passage given below and answer the following questions from 46 to 50.

Adsorption is a spontaneous process and involves unequal distribution of the molecules of the gaseous substance on the surface of solid or liquid. Adsorption is an exothermic process. The attractive forces between adsorbate and adsorbent are either van der Waals' forces or chemical bonds. Adsorption of gases on solids is generally controlled by the factors like temperature, pressure and nature of adsorbate and adsorbent.

The following questions are multiple choice questions. Choose the most appropriate answer :

46. In physisorption process, the attractive forces between adsorbate and adsorbent are
 (a) covalent bonds (b) ionic bonds
 (c) van der Waals' forces (d) H-bonds.
47. Which of the following graph represents the variation of physical adsorption with temperature?



48. Which one of the following processes does not use adsorption?
 (a) Froth floatation process
 (b) Chromatography
 (c) Decolourisation of sugar liquors
 (d) Dissolution of sugar in water
49. Conditions required for increase in van der Waals' adsorption are respectively
 (a) high temperature and low pressure
 (b) high temperature and high pressure
 (c) low temperature and low pressure
 (d) low temperature and high pressure.

(a) chemical adsorption (b) positive adsorption
(c) activated adsorption (d) passive adsorption.

1. (d): Gases, liquids or solids can be adsorbed on the solid surfaces.

3. (b)

5. (a): Substances which themselves are not catalysts but when mixed in small quantities with the catalysts increase their efficiency are called promoters or activators.

7. (c)

9. (d)

12. (c)

14. (a)

18. (d)

20. (b)

22. (b)

24. (a)

29. (a)

$$4\text{NH}_{3(g)} + 5\text{O}_{2(g)} \xrightarrow{\text{Pt}_{(s)}} 4\text{NO}_{(g)} + 6\text{H}_2\text{O}_{(g)}$$

33. (b)

35. (c)

39. (d)

41. (d)

$$2\text{HgS} + 3\text{O}_2 \rightarrow 2\text{HgO} + 2\text{SO}_2; 2\text{HgO} \rightarrow 2\text{Hg} + \text{O}_2$$

44. (d)

48. (d)

50. (c)



Are you ready for Olympiads?

Exam on

3rd Nov & 1st Dec 2022



SYLLABUS*

Section – 1 : Physics : Units and Measurements, Mechanics, Properties of Matter, Heat and Thermodynamics, Oscillations, Waves.

Chemistry : Some Basic Concepts of Chemistry, Structure of Atom, Classification of Elements and Periodicity in Properties, Chemical Bonding and Molecular Structure, States of Matter, Thermodynamics, Equilibrium, Redox Reactions, Hydrogen, The *s*-Block Elements, The *p*-Block Elements (Groups 13 and 14), Organic Chemistry - Some Basic Principles and Techniques, Hydrocarbons, Environmental Chemistry.

Section – 2 : Higher Order Thinking Questions - Syllabus as per Section – 1.

Section – 3 : Sets, Relations and Functions, Principle of Mathematical Induction, Logarithms, Complex Numbers & Quadratic Equations, Linear Inequations, Sequences and Series, Trigonometry, Straight Lines, Conic Sections, Permutations and Combinations, Binomial Theorem, Statistics, Mathematical Reasoning, Limits and Derivatives, Probability, Introduction to 3-D Geometry.

CLASS XI

Total Questions : 50

Time : 1 hr.

PATTERN & MARKING SCHEME			
Section	(1) Physics & Chemistry	(2) Achievers Section	(3) Mathematics or Biology
No. of Questions	25	5	20
Marks per Ques.	1	3	1

OR

Section – 3 : Diversity in the Living World, Structural Organisation in Plants and Animals, Cell : Structure and Functions, Plant Physiology, Human Physiology.

Practice Questions

1. Which of the following have same bond order?

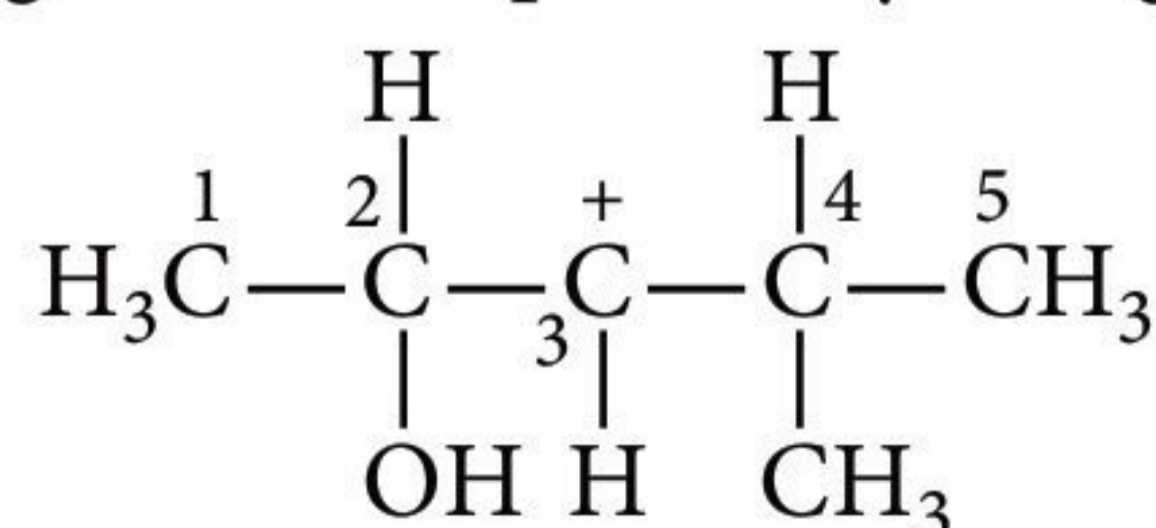
- A. F_2 and O_2^{2-} B. N_2 and O_2
C. O_2 and O_2^- D. N_2 and N_2^+

2. Which of the following statements is/are not correct about the trends in the properties of the elements of a period on going from left to right?

- I. The oxides become more acidic.
II. The elements become less metallic.
III. There is an increase in the number of valence electrons.
IV. The atoms lose their electrons more easily.

- A. I and II only B. IV only
C. III and IV only D. II only

3. In the following carbocation, H/CH₃, that is most likely to migrate to the positively charged C is



- A. CH₃ at C-4 B. H at C-4
C. CH₃ at C-2 D. H at C-2.

4. In which of the following reactions, the underlined substance gets reduced?

- A. $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$
B. $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$
C. $Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + H_2O$
D. $CuO + H_2 \rightarrow Cu + H_2O$

5. Standard electrode potentials of redox couples, A^{2+}/A , B^{2+}/B , C^{2+}/C and D^{2+}/D are 0.3 V, -0.5 V, -0.75 V and 0.9 V respectively. Which of these is best oxidising agent and reducing agent respectively?

- A. D^{2+}/D and B^{2+}/B B. B^{2+}/B and A^{2+}/A
C. D^{2+}/D and C^{2+}/C D. C^{2+}/C and D^{2+}/D

6. Which of the following statements is not correct?

- A. The electronic configuration of Cr is $[Ar]3d^5 4s^1$. (Atomic number of Cr = 24)
B. The magnetic quantum number may have a negative value.
C. In silver atom, 23 electrons have a spin of one type and 24 of the opposite type. (Atomic number of Ag = 47)
D. The oxidation state of nitrogen in HN_3 is -3.

7. 29.2%(w/w) HCl stock solution has a density of 1.25 g mL⁻¹. The molecular weight of HCl is 36.5 g mol⁻¹. The volume (in mL) of stock solution required to prepare a 200 mL solution of 0.4 M HCl is

- A. 8 B. 7 C. 4 D. 5

8. Which of the following does not apply to bonding in metals?
- Non-directional bonds
 - Mobility of valence electrons
 - Delocalisation of electrons
 - Highly directional bonds
9. In the balanced chemical reaction,
 $\text{IO}_3^- + a\text{I}^- + b\text{H}^+ \rightarrow c\text{H}_2\text{O} + d\text{I}_2$
 a , b , c and d respectively correspond to
- 5, 6, 3, 3
 - 5, 3, 6, 3
 - 3, 5, 3, 6
 - 5, 6, 5, 5
10. The enthalpies of combustion of $\text{S}_{(s)}$, $\text{SO}_{2(g)}$ and $\text{H}_{2(g)}$ are -298.2 , -98.7 and $-287.3 \text{ kJ mol}^{-1}$. If the enthalpy of reaction, $\text{SO}_{3(g)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{H}_2\text{SO}_{4(l)}$ is $-130.2 \text{ kJ mol}^{-1}$, the enthalpy of formation of $\text{H}_2\text{SO}_{4(l)}$ would be
- $-814.4 \text{ kJ mol}^{-1}$
 - $-650.3 \text{ kJ mol}^{-1}$
 - $-554.2 \text{ kJ mol}^{-1}$
 - $-435.5 \text{ kJ mol}^{-1}$
11. Consider the reaction
 $\text{CO}_{(g)} + \text{H}_2\text{O}_{(g)} \rightleftharpoons \text{CO}_{2(g)} + \text{H}_{2(g)}$
 The equilibrium amount of $\text{CO}_{2(g)}$ can be increased at a given temperature by
- adding a suitable catalyst
 - decreasing the volume of the container
 - adding an inert gas at constant pressure
 - increasing the amount of $\text{CO}_{(g)}$.
12. 3-Methylbut-1-ene on reaction with HBr gives (as a major product)
- $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{Br}$
 - $(\text{CH}_3)_2\text{CBrCH}_2\text{CH}_3$
 - $(\text{CH}_3)_2\text{CHCHBrCH}_3$
 - $(\text{CH}_3)_3\text{CCH}_2\text{Br}$
13. An organic compound with molecular formula C_6H_{12} upon ozonolysis gave only acetone as the product. The compound is
- 2,3-Dimethyl-1-butene
 - 3-Hexene
 - 2-Hexene
 - 2,3-Dimethyl-2-butene
14. Which one of the following is spontaneous at all temperatures?
- $\text{H}_{2(g)} \rightarrow 2\text{H atom}$
 $\Delta H^\circ = 436 \text{ kJ mol}^{-1}$, $\Delta S^\circ = 90.7 \text{ kJ/mol/K}$
 - $\frac{1}{2}\text{N}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \rightarrow \text{NO}_{(g)}$
 $\Delta H^\circ = 90.3 \text{ kJ}$, $\Delta S^\circ = 3.0 \text{ kJ/mol/K}$

- $2\text{NO}_{2(g)} \rightarrow \text{N}_2\text{O}_{4(g)}$
 $\Delta H^\circ = -56.0 \text{ kJ}$, $\Delta S^\circ = +17.7 \text{ kJ/mol/K}$
- $\text{H}_2\text{O}_{2(g)} \rightarrow \text{H}_2\text{O}_{(l)} + 1/2 \text{O}_{2(g)}$
 $\Delta H^\circ = 98.3 \text{ kJ}$, $\Delta S^\circ = 80.0 \text{ kJ/mol/K}$

15. The mass of KClO_3 required to produce 2.4 mol of oxygen by catalytic decomposition will be
 [Given that : $2\text{KClO}_{3(s)} \rightarrow 2\text{KCl}_{(s)} + 3\text{O}_{2(g)}$; molar mass of $\text{KClO}_3 = 122.5 \text{ g}$]
- 19.6 g
 - 196.0 g
 - 122.5 g
 - 245.0 g

ACHIEVERS SECTION

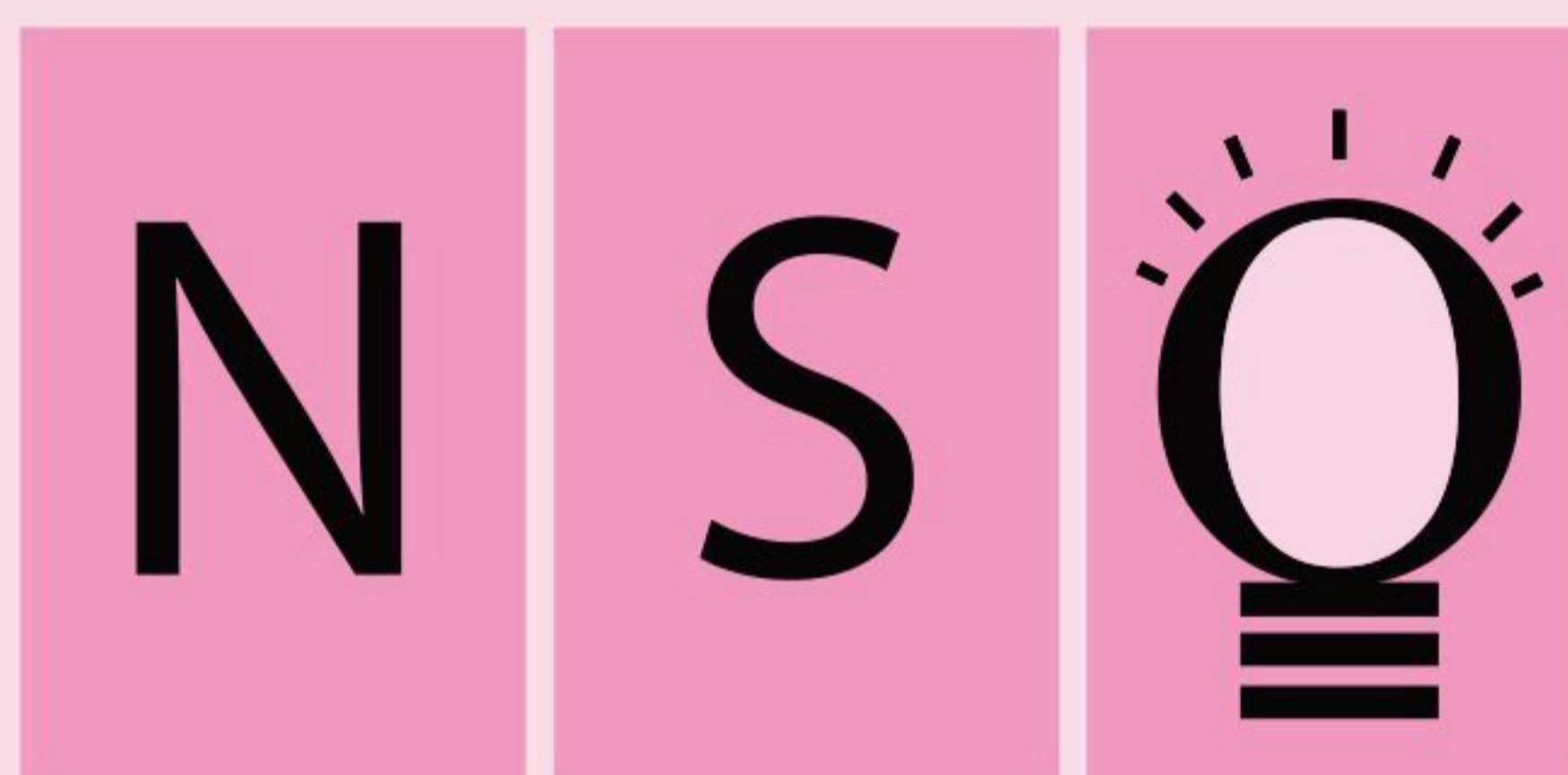
16. Read the given passage and fill in the blanks by selecting an appropriate option.
- A hydrocarbon, (P) on reaction with sodamide in liquid ammonia followed by reaction with ethyl iodide gives (Q). (Q) on ozonolysis gives diketone (R) which on oxidation gives propanoic acid only. (P) on catalytic hydrogenation with excess of hydrogen gas gives (S) whose molecular mass is 58.
- $(P) \rightarrow \text{CH}_3-\text{CH}_2-\text{C}\equiv\text{CH}$;
 $(Q) \rightarrow \text{CH}_3-\text{CH}_2-\text{C}\equiv\text{C}-\text{CH}_3$;
 $(R) \rightarrow \text{CH}_3-\text{CH}_2-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{O}}{\parallel}\text{C}-\text{CH}_3$;
 $(S) \rightarrow \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_3$
 - $(P) \rightarrow \text{CH}_3-\text{CH}_2-\text{C}\equiv\text{CH}$;
 $(Q) \rightarrow \text{CH}_3-\text{CH}_2-\text{C}\equiv\text{C}-\text{CH}_2-\text{CH}_3$;
 $(R) \rightarrow \text{CH}_3-\text{CH}_2-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{O}}{\parallel}\text{C}-\text{CH}_2-\text{CH}_3$;
 $(S) \rightarrow \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_3$
 - $(P) \rightarrow \text{CH}_3-\text{CH}_2-\text{C}\equiv\text{C}-\text{CH}_3$;
 $(Q) \rightarrow \text{CH}_3-\text{CH}_2-\text{C}\equiv\text{C}-\text{CH}_2-\text{CH}_3$;
 $(R) \rightarrow \text{CH}_3-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{O}}{\parallel}\text{C}-\text{CH}_3$;
 $(S) \rightarrow \text{CH}_3-\text{CH}_2-\text{CH}_3$
 - $(P) \rightarrow \text{CH}_3-\text{C}\equiv\text{C}-\text{CH}_2-\text{CH}_3$;
 $(Q) \rightarrow \text{CH}_3-\text{CH}_2-\text{C}\equiv\text{C}-\text{CH}_2-\text{CH}_3$;
 $(R) \rightarrow \text{CH}_3-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{O}}{\parallel}\text{C}-\text{CH}_3$;
 $(S) \rightarrow \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_3$



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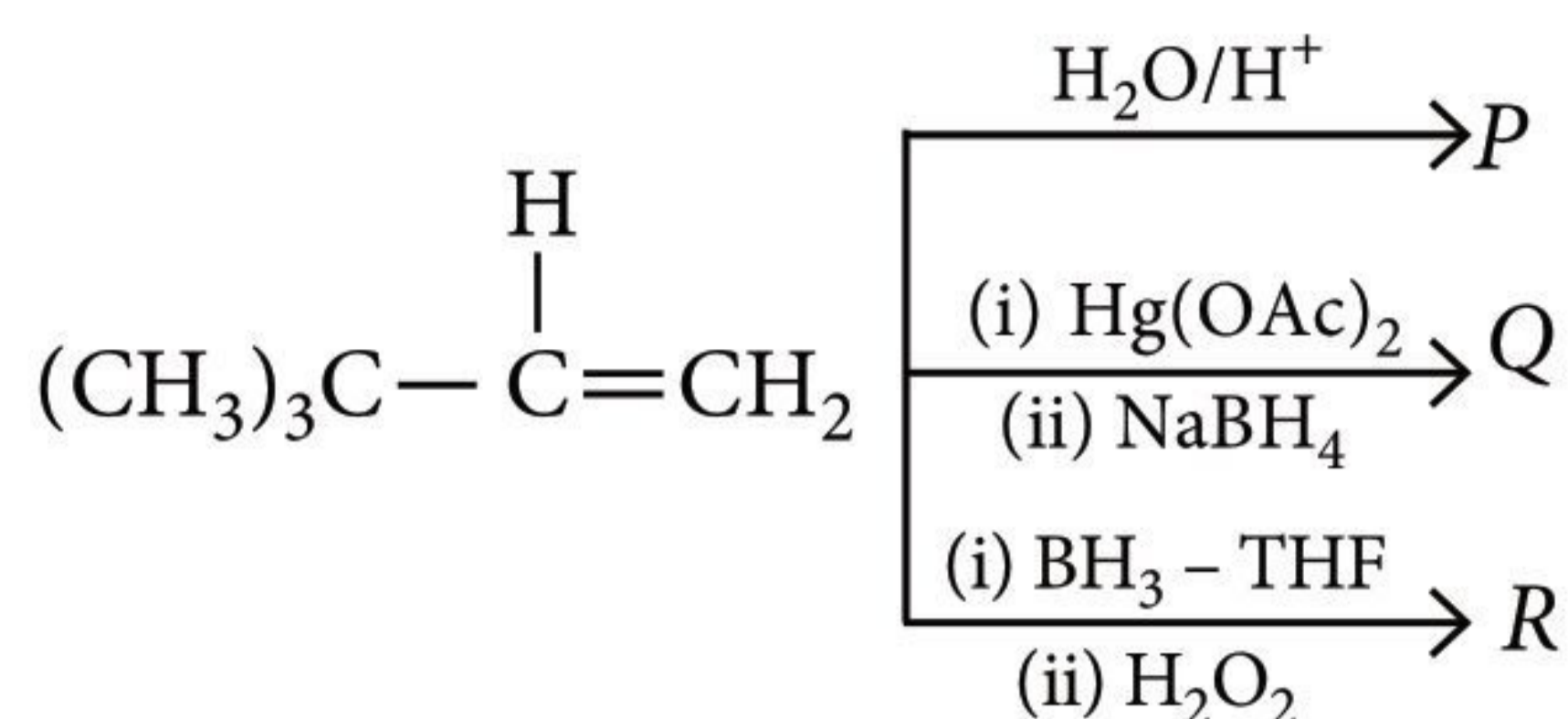
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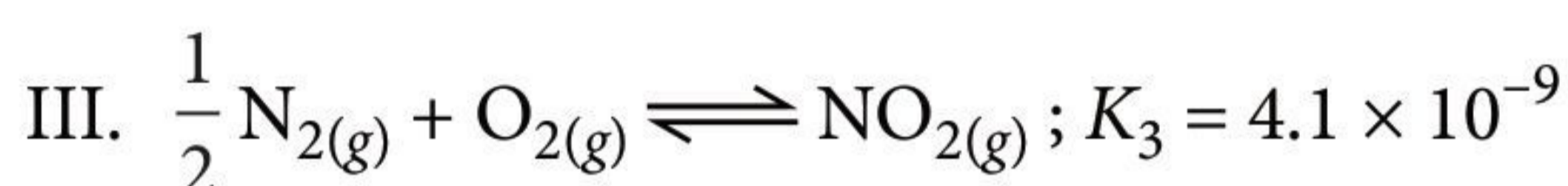
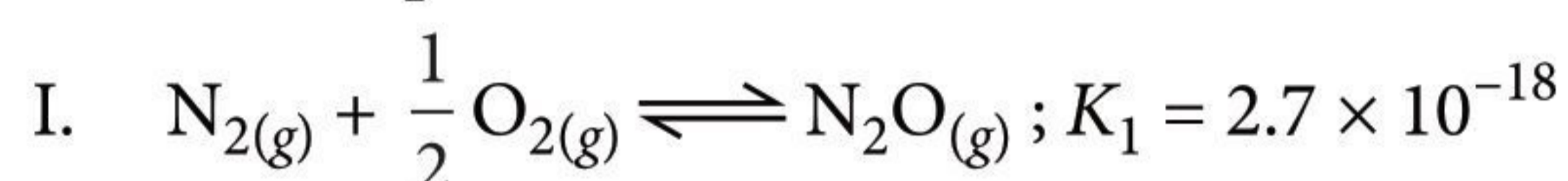
17. Fill in the blanks by selecting an appropriate option :



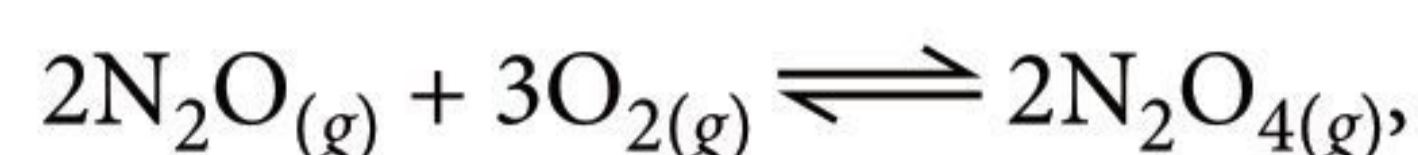
Here optically, P is x, Q is y and R is z.

- | | <u>x</u> | <u>y</u> | <u>z</u> |
|----|----------|----------|----------|
| A. | Active | inactive | active |
| B. | Active | active | inactive |
| C. | Inactive | active | inactive |
| D. | Inactive | inactive | active |

18. Given the equilibrium constant values,



Thus, for the reaction,



the value of equilibrium constant is

- A. 5.46×10^7 B. 5.46×10^{-7}
 C. 1.832×10^{-6} D. 1.832×10^6

19. The positions of elements P to T in the periodic table are given as :

P: Element in the fourth period and group 14

Q: Element in the third period and group 16

R: Element in the sixth period and group 13

S: Element in the second period and group 18

T: Element in the fourth period and group 16

Arrange these elements in the expected order of increasing first ionisation energy.

- A. $P < Q < R < S < T$ B. $T < S < R < Q < P$
 C. $R < P < T < Q < S$ D. $S < Q < T < P < R$

20. Two fast moving particles X and Y are associated with de-Broglie wavelength 1 nm and 4 nm respectively. If mass of X is nine times the mass of Y then calculate the ratio of kinetic energies of X and Y.

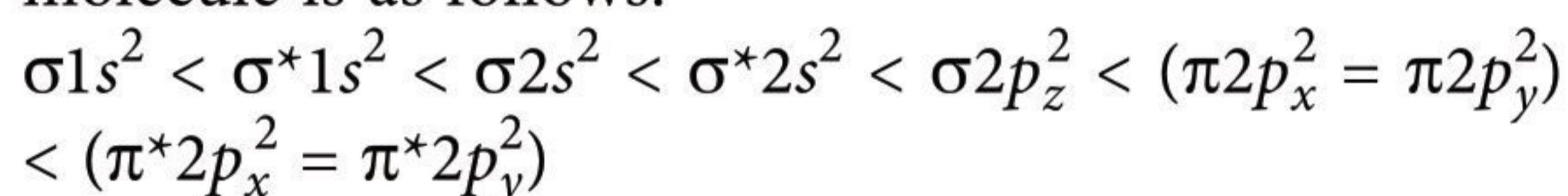
- A. 1.78 B. 2.68 C. 2.50 D. 3.45

Darken your choice with HB Pencil

1. (A) (B) (C) (D)	5. (A) (B) (C) (D)	9. (A) (B) (C) (D)	13. (A) (B) (C) (D)	17. (A) (B) (C) (D)
2. (A) (B) (C) (D)	6. (A) (B) (C) (D)	10. (A) (B) (C) (D)	14. (A) (B) (C) (D)	18. (A) (B) (C) (D)
3. (A) (B) (C) (D)	7. (A) (B) (C) (D)	11. (A) (B) (C) (D)	15. (A) (B) (C) (D)	19. (A) (B) (C) (D)
4. (A) (B) (C) (D)	8. (A) (B) (C) (D)	12. (A) (B) (C) (D)	16. (A) (B) (C) (D)	20. (A) (B) (C) (D)

SOLUTIONS

1. (A) : The molecular orbital configuration of F_2 molecule is as follows:



$$\text{Bond order} = \frac{1}{2} (\text{Bonding electrons} - \text{Anti-bonding electrons}) = \frac{1}{2} (10 - 8) = 1$$

The molecular orbital configuration of O_2^{2-} is as follows:

$$\sigma 1s^2 < \sigma^* 1s^2 < \sigma 2s^2 < \sigma^* 2s^2 < \sigma 2p_z^2 < (\pi 2p_x^2 = \pi 2p_y^2) < (\pi^* 2p_x^2 = \pi^* 2p_y^2)$$

$$\text{Bond order} = \frac{1}{2} (10 - 8) = 1$$

Hence, F_2 and O_2^{2-} have the same bond order.

2. (B)

3. (D) : The H at C - 2 is most likely to migrate at C - 3 because the carbocation developed at C - 2 is the most stable due to +M effect of oxygen atom.

4. (D) : In this reaction, Cu gets reduced as its oxidation state changes from +2 (in CuO) to 0 (in Cu).

5. (C) : The redox couple, C^{2+}/C has the largest negative value of standard electrode potential thereby, it is the best reducing agent. The redox couple, D^{2+}/D has the largest positive value of standard electrode potential thereby, it is the best oxidising agent.

6. (D) : (A) is correct because the electronic configuration of Cr ($Z = 24$) is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$. (B) is correct because magnetic quantum number (m_l) can have values from $-l$ to 0 to $+l$ i.e., it can have negative values.

(C) is correct because the electronic configuration of Ag ($Z = 47$) is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^1$. From here we find 23 electrons have spin of one type and 24 electrons have spin of opposite type.

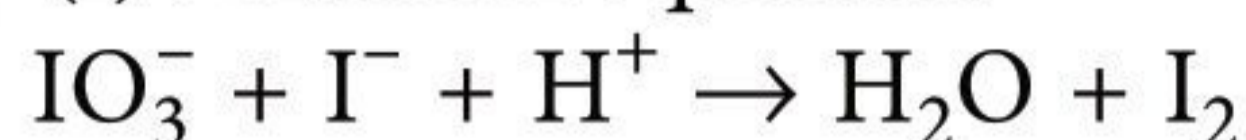
(D) is not correct because oxidation number of N in HN_3 is $-1/3$.

7. (A)

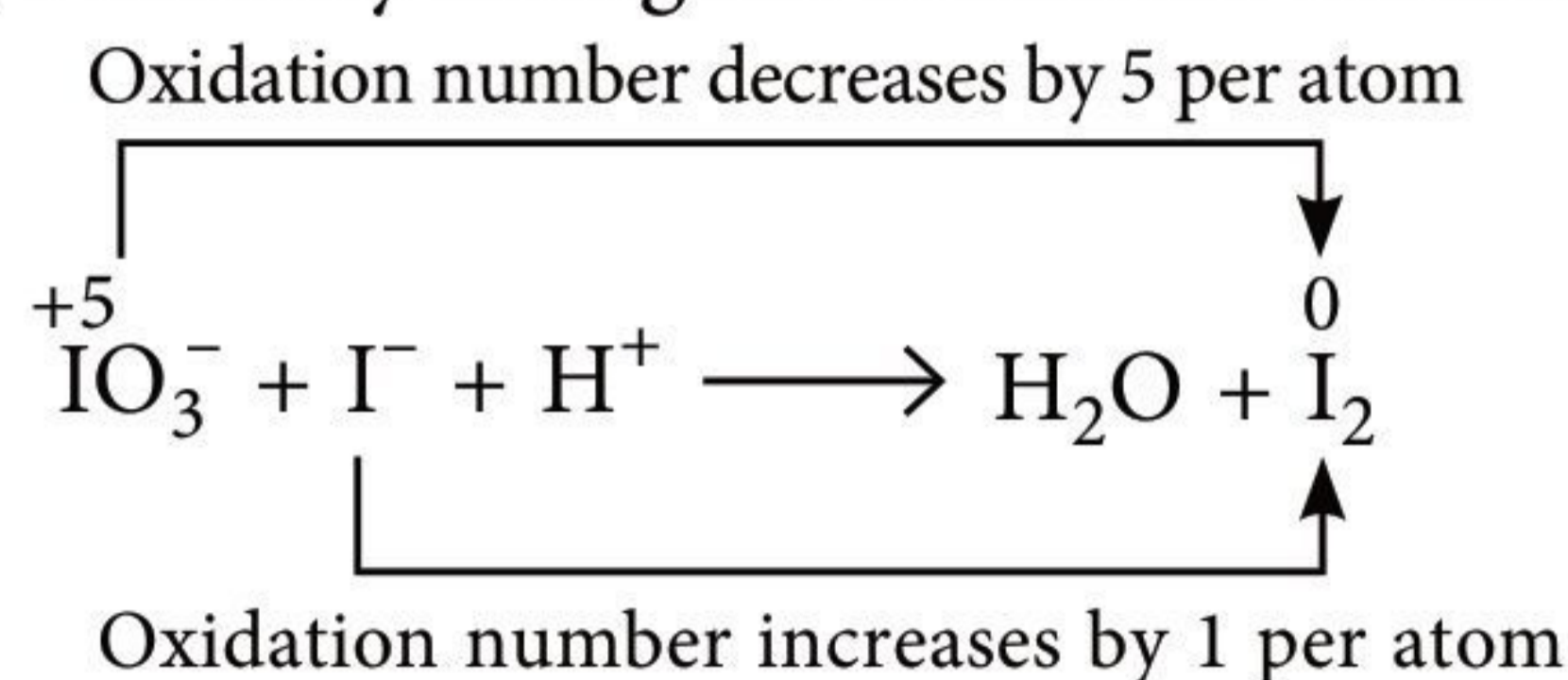
8. (D) : Metallic bonds are non-directional.

9. (A) : Let us balance the given equation by oxidation number method.

Step (i) : Skeletal equation



Step (ii) : Identify change in oxidation number



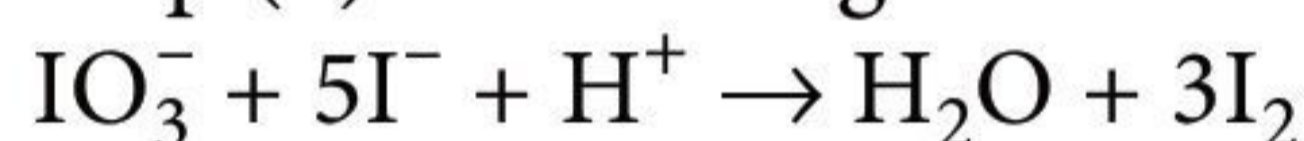
Step (iii) : Total increase in oxidation number = 1 per I atom.

Total decrease in oxidation number = 5 per I atom.

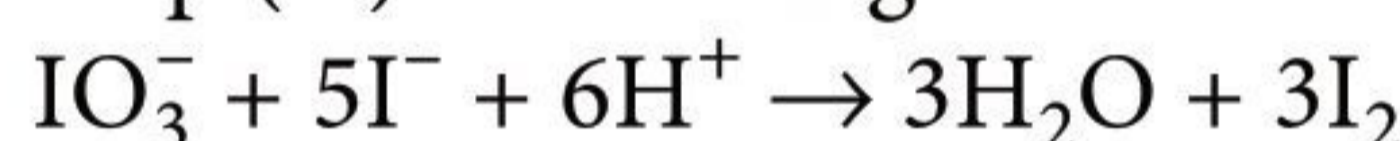
Step (iv) : Equalising total increase and decrease in oxidation number.



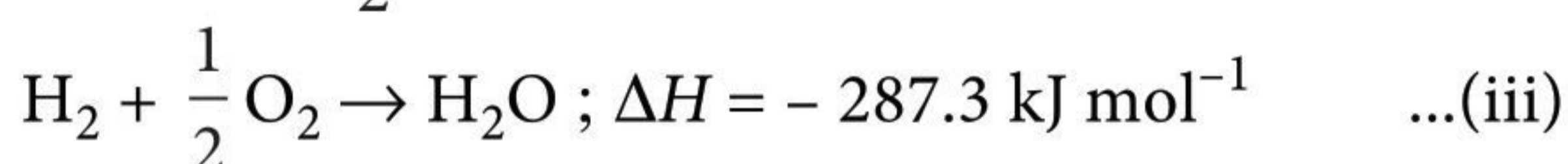
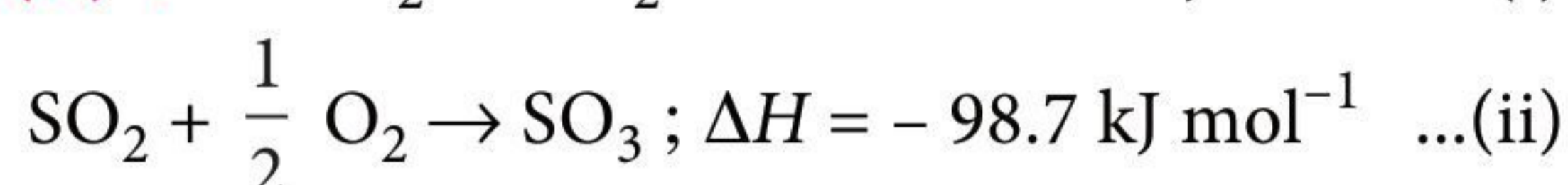
Step (v) : Balancing all atoms other than H and O



Step (vi) : Balancing H and O atoms

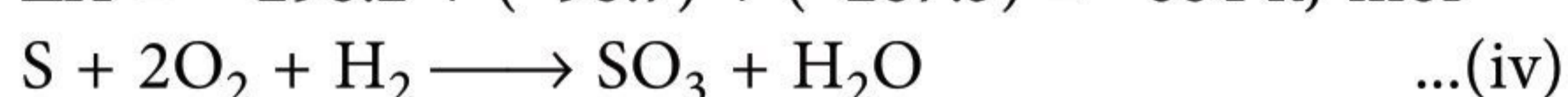


10. (A) : $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$; $\Delta H = -298.2 \text{ kJ mol}^{-1}$... (i)

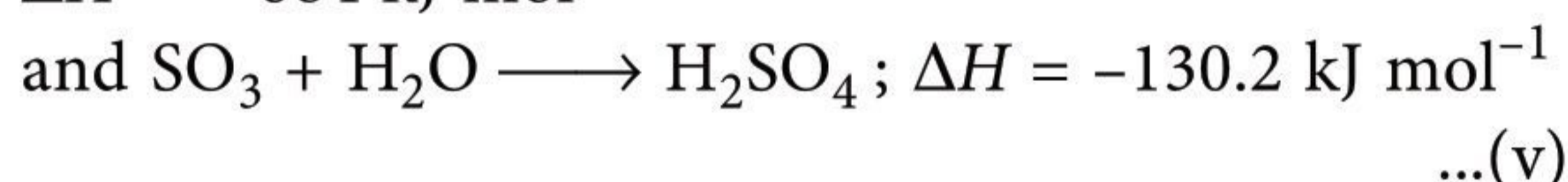


Adding equation (i), (ii) and (iii),

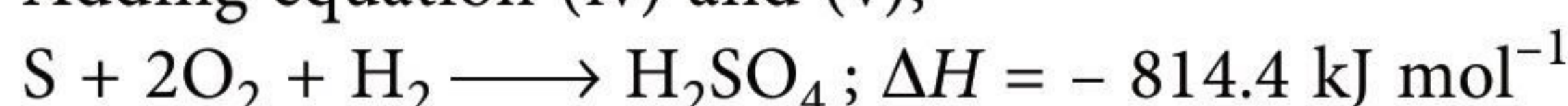
$$\Delta H = -298.2 + (-98.7) + (-287.3) = -684 \text{ kJ mol}^{-1}$$



$$\Delta H = -684 \text{ kJ mol}^{-1}$$

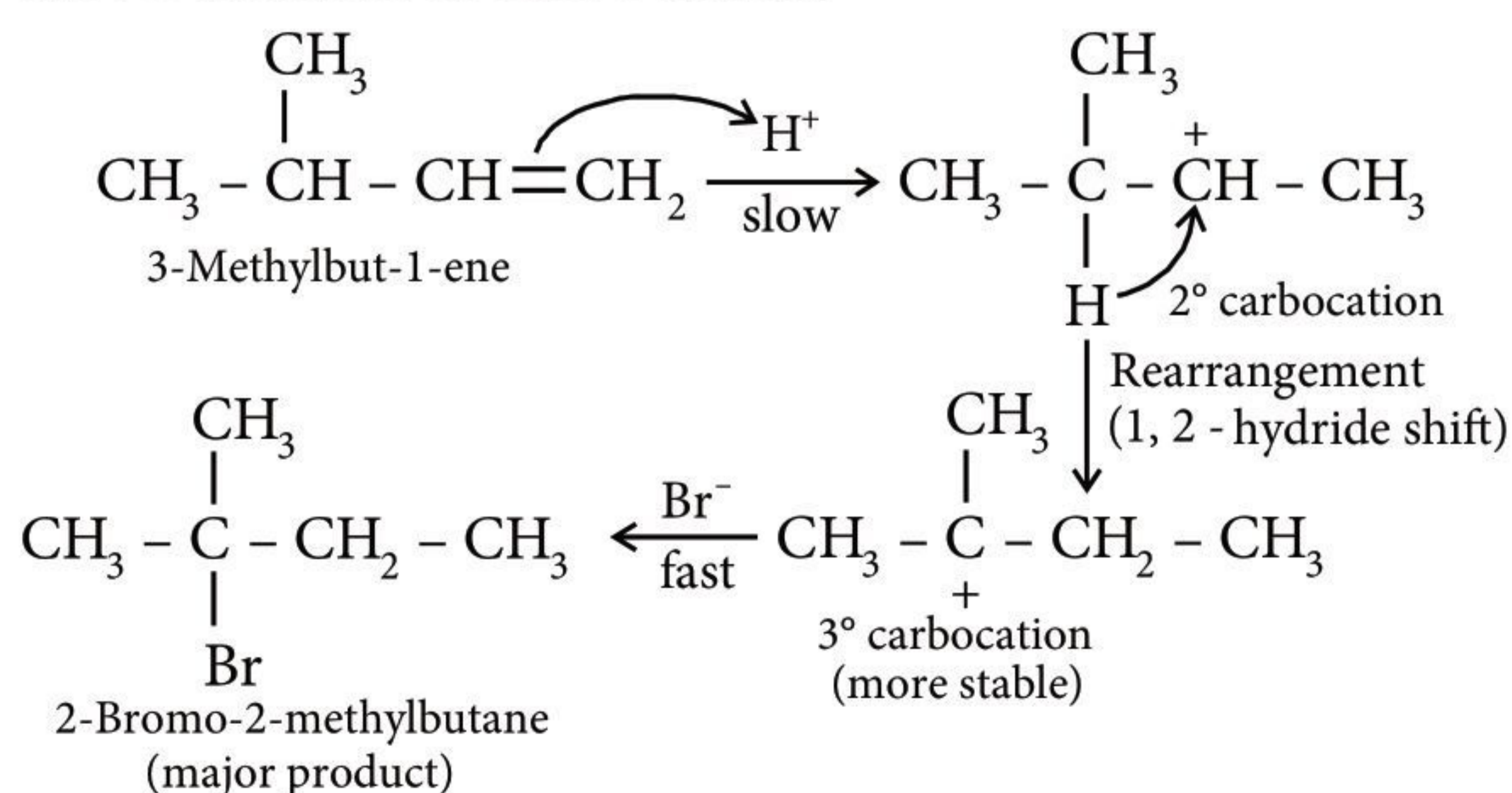


Adding equation (iv) and (v),



11. (D)

12. (B) : Addition of HBr to alkenes occurs through the formation of carbocation.



13. (D)

14. (C) : According to Gibbs - Helmholtz equation, $\Delta G = \Delta H - T\Delta S$

For spontaneous process, $\Delta G < 0$

When, $\Delta H = -\text{ve}$, $\Delta S = +\text{ve}$, then $\Delta G = -\text{ve}$ and is spontaneous at all temperatures.

15. (B) : $2\text{KClO}_{3(s)} \rightarrow 2\text{KCl}_{(s)} + 3\text{O}_{2(g)}$

Molar mass of $\text{KClO}_3 = 122.5 \text{ g/mol}$

245 g of KClO_3 gives 96 g of O_2 .

$$245 \text{ g of } \text{KClO}_3 = \frac{245}{122.5} \text{ mol} = 2 \text{ mol}$$

$$\text{and } 96 \text{ g of } \text{O}_2 = \frac{96}{32} = 3 \text{ mol}$$

3 mol of O_2 is produced by 2 mol of KClO_3 .

1 mol of O_2 is produced by $\frac{2}{3}$ mol of KClO_3 .

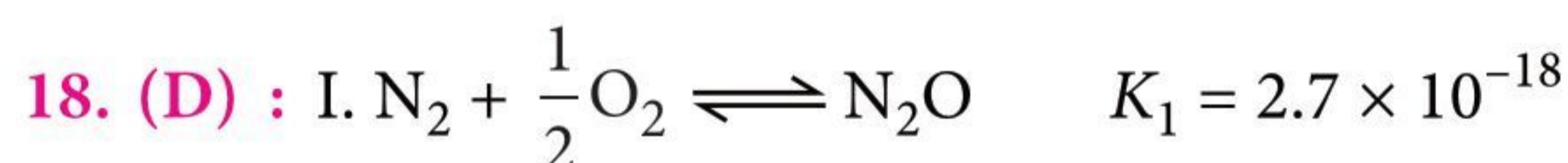
$$\begin{aligned} 2.4 \text{ mol of } \text{O}_2 \text{ is produced by } \frac{2}{3} \times 2.4 \text{ mol of } \text{KClO}_3 \\ = 1.6 \text{ mol of } \text{KClO}_3 \end{aligned}$$

Therefore, the mass of KClO_3 required to produce 2.4 mol of oxygen = $1.6 \times 122.5 \text{ g} = 196 \text{ g}$.

[\because Molar mass of $\text{KClO}_3 = 122.5$]

16. (B)

17. (C)





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CLASS

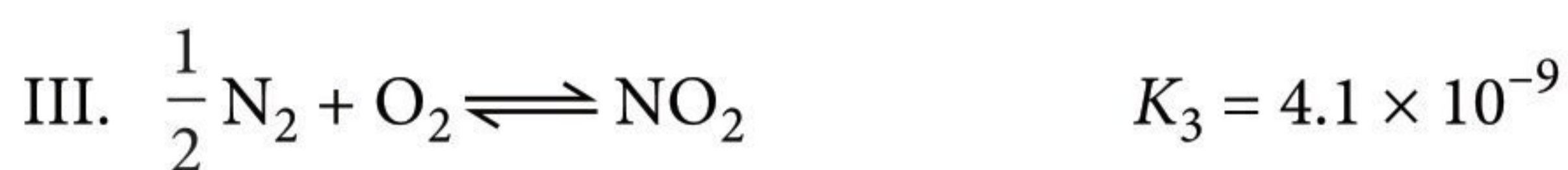
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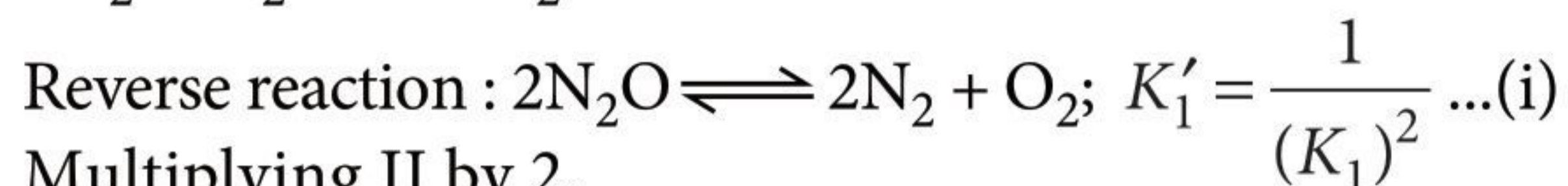
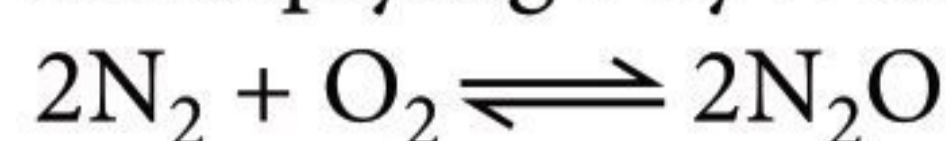
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Multiplying I by 2 and then reversing it,



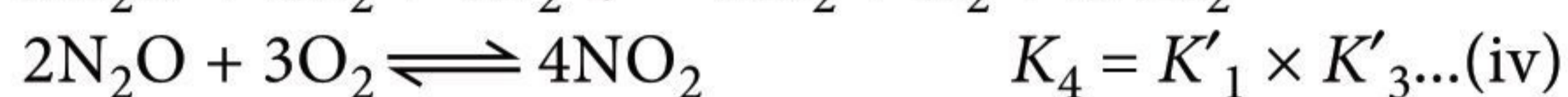
Multiplying II by 2,



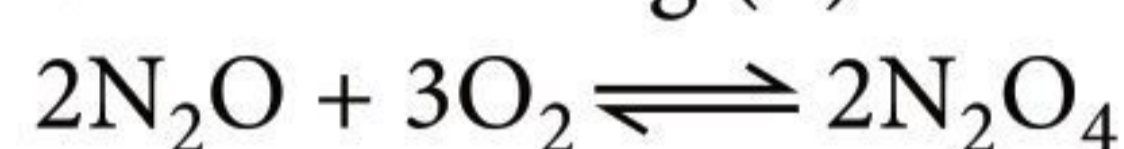
Multiplying III by 4,



Adding (i) and (iii),



On subtracting (ii) from (iv), we get



Let K_5 be the equilibrium constant for the above reaction.

$$\text{Now, } K_5 = \frac{K'_1 \times K'_3}{K'_2} = \frac{\left(\frac{1}{2.7 \times 10^{-18}}\right)^2 \times (4.1 \times 10^{-9})^4}{(4.6 \times 10^{-3})^2}$$

$$= \frac{0.137 \times 10^{36} \times 282.57 \times 10^{-36}}{21.16 \times 10^{-6}} = 1.83 \times 10^6$$

19. (C) : The ionization energy of elements decreases down the group because as one moves down a group, electrons are located in successively higher energy levels, farther away from the attraction of the nucleus. On the other hand, across a period, ionisation energy increases. As elements have successively more electrons across a period, atoms get closer and closer to their goal of achieving an octet. So removal of electrons becomes difficult as atoms approach an octet. Therefore, the correct increasing order of first ionization energy of the given elements is $R < P < T < Q < S$.

20. (A) : $\lambda = \frac{h}{mv}$; $m_x = 9m_y$

$$\frac{\lambda_y}{\lambda_x} = \frac{m_x v_x}{m_y v_y} \Rightarrow \frac{4}{1} = \frac{9 \times v_x}{1 \times v_y} \Rightarrow \frac{v_x}{v_y} = \frac{4}{9}; K.E. = \frac{1}{2}mv^2$$

$$\text{Ratio of } K.E. = \frac{K.E._x}{K.E._y} = \frac{m_x \times v_x^2}{m_y \times v_y^2} = \frac{9}{1} \times \left(\frac{4}{9}\right)^2 = \frac{16}{9} = 1.78$$

For other sections/subjects please refer to
Physics For You and Biology Today



UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I

1. NOAENTRETFMI
2. NYTRAIIEPTC
3. LANVIUACSOTIN
4. TUELRMGALY
5. LESTPRE
6. POLCUTAARCM
7. NUEHQCNIG
8. DOEIUEMTER
9. YELNPDOTAET
10. CLIOCUSNO

Column II

- (a) Commercial zinc having 3% impurities, mainly lead.
- (b) A white crystalline substance, $\text{C}_6\text{H}_{11}\text{NO}$, used in the synthesis of nylon-6.
- (c) The adsorption of gases on the surface of metal. In this process, atoms or molecules or ions occupy interstitial sites in solid lattice.
- (d) The process of breaking down of large molecules into simpler ones due to action of enzymes.
- (e) An apparatus for the volumetric analysis of gases.
- (f) When several donor atoms are present in a single ligand.
- (g) A method of improving the quality of rubber by heating it with sulphur.
- (h) The entire scientific and technological processes used for isolation of metal from its ore.
- (i) Chemical substances which are used to bring down body temperature in high fever.
- (j) A process of toughening steel by rapid cooling of hot steel with oil or water.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month.
Winners' names will be published in next issue.

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Exam on

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CLASS XII

SYLLABUS*

Section – 1 : Physics : Electricity and Magnetism, Electromagnetic Induction, Alternating current, Electromagnetic waves, Optics, Modern Physics, Semiconductor Electronics, Communication Systems.

Chemistry : Solid State, Solutions, Electrochemistry, Chemical Kinetics, Surface Chemistry, General Principles and Processes of Isolation of Elements, *p*-Block Elements (Group 15 to 18), *d*- & *f*-Block Elements, Coordination Compounds, Haloalkanes and Haloarenes, Alcohols, Phenols and Ethers, Aldehydes, Ketones and Carboxylic Acids, Amines, Biomolecules, Polymers, Chemistry in Everyday Life.

Section – 2 : Higher Order Thinking Questions - Syllabus as per Section – 1.

Section – 3 : Relations and Functions, Inverse Trigonometric Functions, Matrices and Determinants, Continuity and Differentiability, Application of Derivatives, Integrals, Application of Integrals, Differential Equations, Vector Algebra, Three Dimensional Geometry, Probability, Linear Programming.

OR

Section – 3 : Reproduction, Genetics and Evolution, Biology in Human Welfare, Biotechnology, Ecology.

Total Questions : 50

Time : 1 hr.

PATTERN & MARKING SCHEME			
Section	(1) Physics & Chemistry	(2) Achievers Section	(3) Mathematics or Biology
No. of Questions	25	5	20
Marks per Ques.	1	3	1

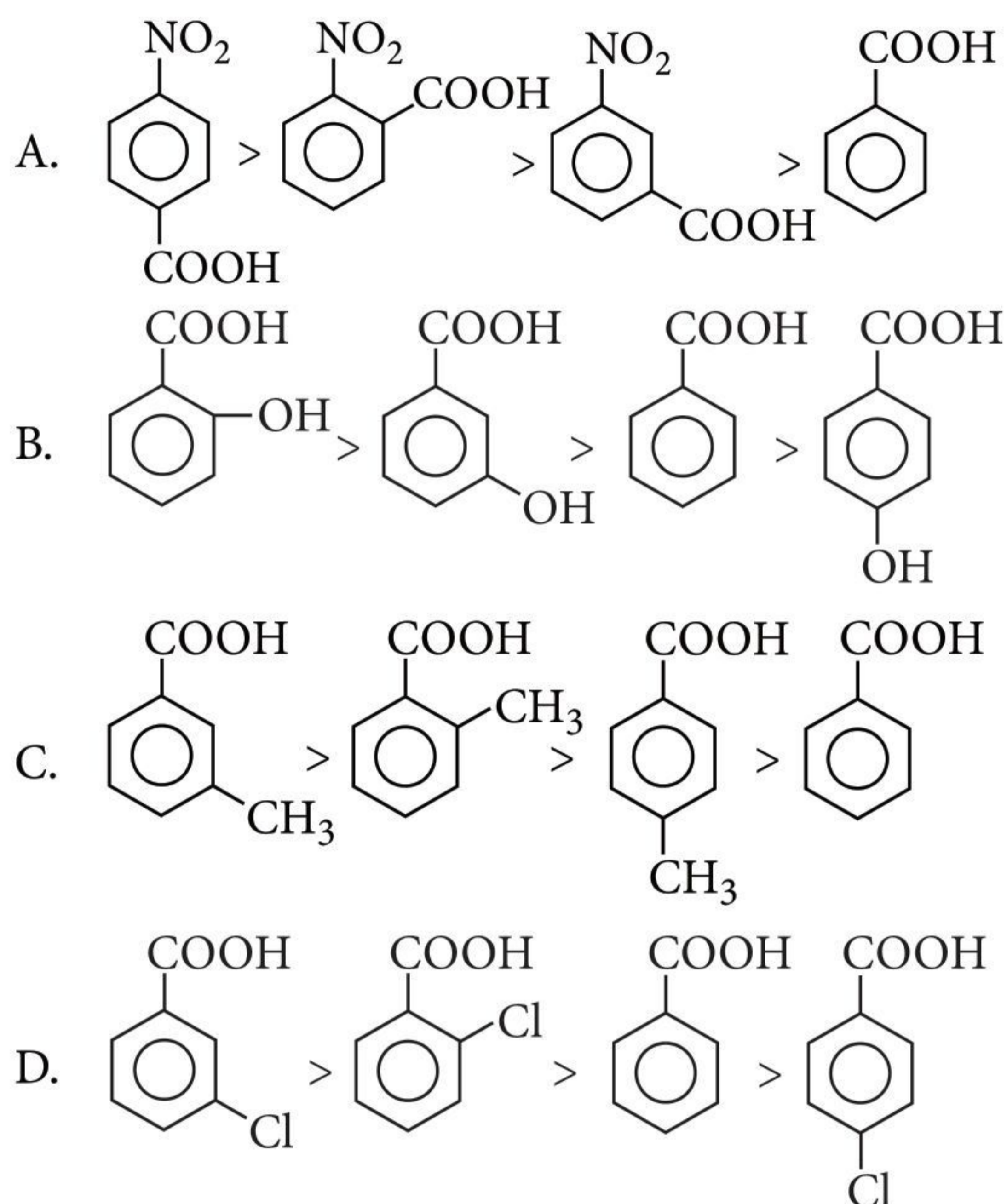
Practice Questions

- The molality of a solution containing a non-volatile solute if the vapour pressure is 2% below the vapour pressure of pure water is
A. 0.1 m B. 1.1 m
C. 0.05 m D. 1.5 m
- Increasing value of magnetic moments of
I. $[\text{Fe}(\text{CN})_6]^{4-}$ II. $[\text{Fe}(\text{CN})_6]^{3-}$
III. $[\text{Cr}(\text{NH}_3)_6]^{3+}$ IV. $[\text{Ni}(\text{H}_2\text{O})_4]^{2+}$
is
A. $\text{I} < \text{II} < \text{III} < \text{IV}$ B. $\text{IV} < \text{III} < \text{II} < \text{I}$
C. $\text{II} < \text{III} < \text{I} < \text{IV}$ D. $\text{I} < \text{II} < \text{IV} < \text{III}$
- Consider the given statements :
I. First ionisation energy of Mn is higher than that of Cr.
II. Except copper, 3*d* elements are good reducing agents.
III. The first ionisation energy for 5*d* series is much higher than 3*d* and 4*d* series.
IV. Atomic radii of 3rd transition series elements are much lower than those of 2nd transition series elements.
Which of the given statements is/are correct?
A. I only B. IV only
C. I and II only D. I, II and III only
- The correct increasing order of acidity for the given compounds is

A. $\text{IV} < \text{II} < \text{III} < \text{I}$ B. $\text{I} < \text{IV} < \text{III} < \text{II}$
C. $\text{II} < \text{III} < \text{I} < \text{IV}$ D. $\text{II} < \text{III} < \text{IV} < \text{I}$
- For the following cell reaction ;
 $\text{Sn}_{(s)} + \text{Pb}_{(aq)}^{2+} \rightleftharpoons \text{Sn}_{(aq)}^{2+} + \text{Pb}_{(s)}$
If $E_{\text{Sn}^{2+}/\text{Sn}}^\circ = -0.136 \text{ V}$ and $E_{\text{Pb}^{2+}/\text{Pb}}^\circ = -0.126 \text{ V}$, then ratio of Pb^{2+} to Sn^{2+} concentrations needed to reverse the given reaction is
A. more than 0.458 B. less than 0.458
C. more than 0.677 D. more than 0.877
- Study the given reactions.
 $\text{NiCl}_2 + \text{KCN} \xrightarrow{\text{(excess)}} \text{X}$ (Cyano complex)
 $\text{X} + \text{conc. HCl} \xrightarrow{\text{(excess)}} \text{Y}$ (Chloro complex)
If the coordination number of nickel(II) ion is 4, then which of the following statements is incorrect regarding (X) and (Y)?

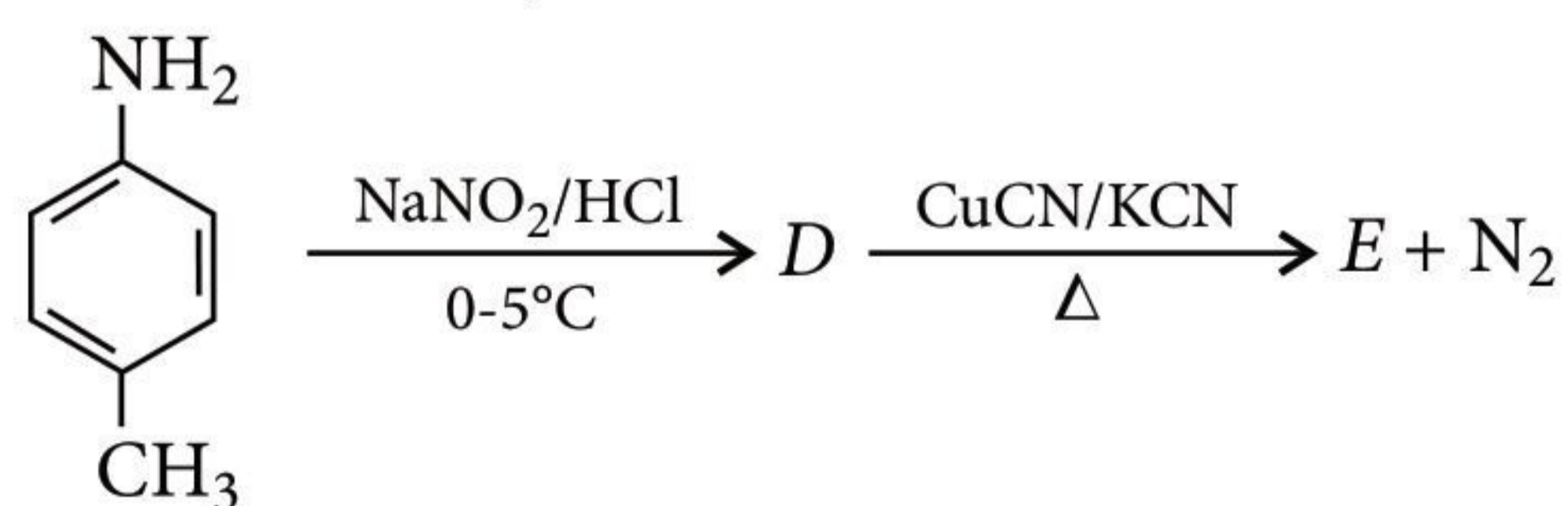
- A. The possible d -orbital energy levels of Ni in (X) is $d_{xz} = d_{yz} < d_{z^2} < d_{xy} < d_{x^2-y^2}$.
- B. The number of unpaired electrons in (Y) is 2.
- C. Both (X) and (Y) are paramagnetic.
- D. The hybridisation of (X) and (Y) are respectively dsp^2 and sp^3 .

7. Which of the following represents the correct order of the acidic strength of the given compounds?

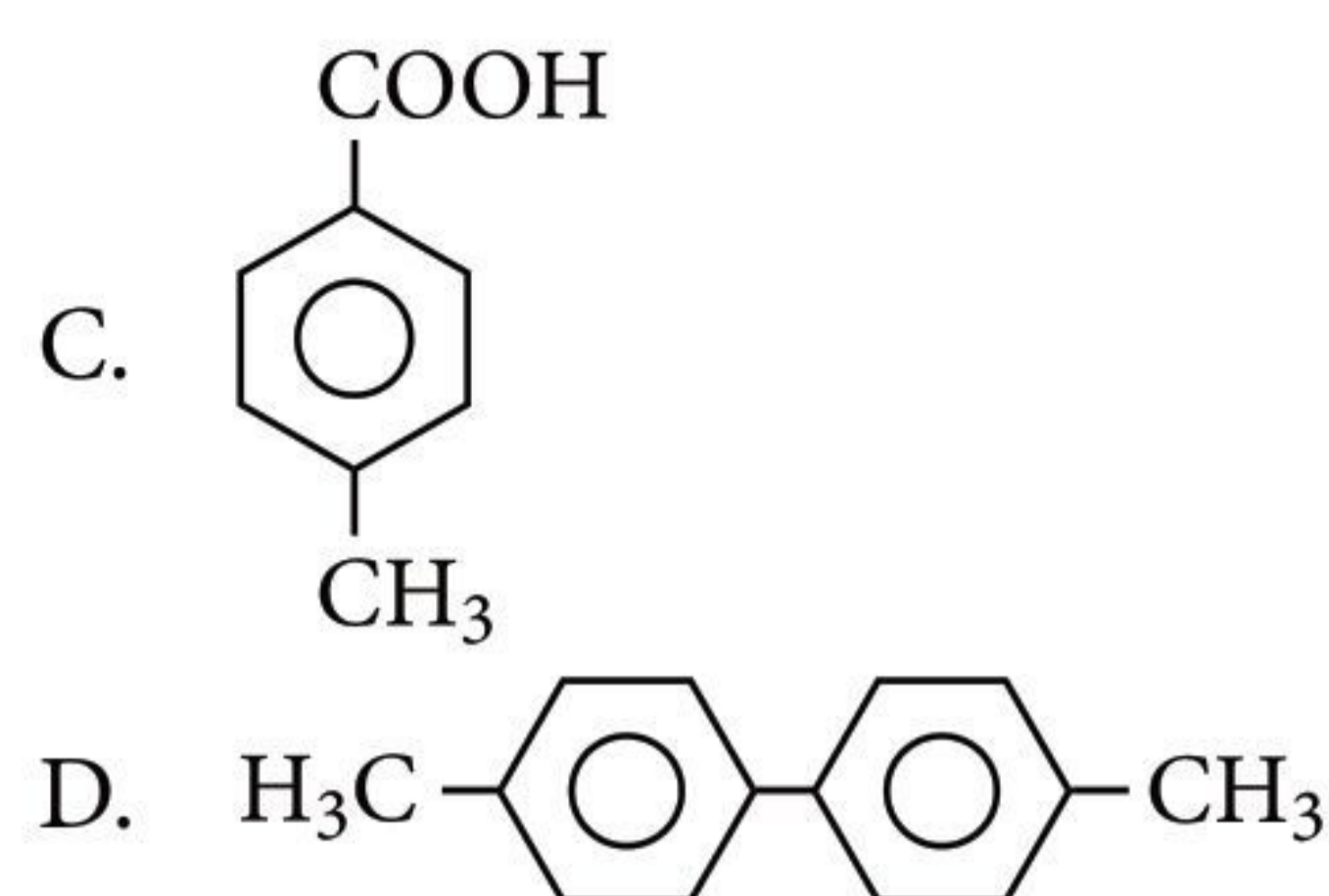


8. Choose the incorrect order among the following.
- A. $SCN^- < C_2O_4^{2-} < NH_3 < CN^-$: Ligand field strength
- B. $[Ni(NO_2)_6]^{4-} < [Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+}$: Wavelength of absorption in visible region
- C. $[MnCl_4]^{2-} < [CoCl_4]^{2-} < [Fe(CN)_6]^{4-}$: Magnetic moment
- D. $[Ni(CO)_4] < [Cu(NH_3)_4]Cl_2 < [Co(NH_3)_6]Cl_3$: Ionic conductivity

9. In the reaction,



The product (E) is



10. Pick the wrong statement from the following :

- A. Consumption of citrus fruits and green leafy vegetables in food prevents scurvy.
- B. Deficiency of vitamin B₆ (pyridoxine) results in convulsions.
- C. Sources of vitamin B₁ are yeast, milk, green vegetables and cereals.
- D. Deficiency of vitamin D causes xerophthalmia.

11. Which of the following is not optically active ?

- A. Glycine B. Tyrosine
- C. Lysine D. Alanine

12. Which of the following amine will not give carbylamine reaction?

- A. Ethyl amine B. Phenyl amine
- C. Methyl amine D. Dimethyl amine

13. Acetophenone cannot be prepared easily starting from

- A. $C_6H_5CH(OH)CH_3$ B. $C_6H_5CH_3$
- C. $C_6H_5C\equiv CH$ D. C_6H_6

14. The major product obtained on interaction of phenol with sodium hydroxide and carbon dioxide is

- A. benzoic acid B. salicylaldehyde
- C. salicylic acid D. phthalic acid.

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CLASS

12

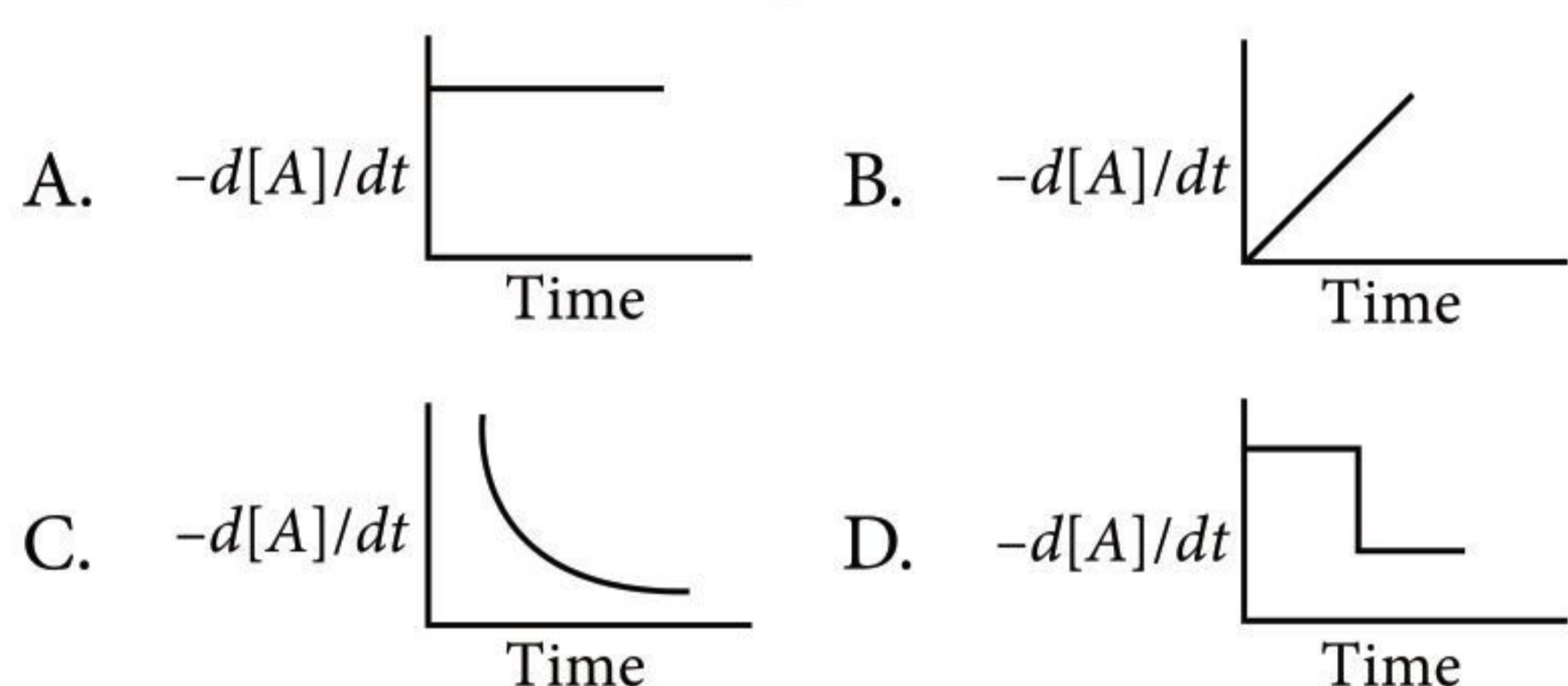
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15. For a first order reaction, $A \rightarrow P$, $t_{1/2}$ (half-life) is 10 days. The time required for $\frac{1}{4}$ th conversion of A into P (in days) is
($\ln 2 = 0.693$, $\ln 3 = 1.1$)
A. 5 B. 4.1 C. 3.2 D. 2.5

ACHIEVERS SECTION

16. If graph between concentration of the product and time of the reaction ($A \rightarrow B$) is shown as :
then, the graph between $-d[A]/dt$ and time will be of the type



17. A carbonyl compound with molecular weight 86, does not reduce Fehling's solution but forms crystalline bisulphite derivatives and gives iodoform test. The possible compounds can be
A. 2-pentanone and 3-pentanone
B. 2-pentanone and 3-methyl-2-butanone
C. 2-pentanone and pentanal
D. 3-pentanone and 3-methyl-2-butanone.
18. Match the chemical conversions in List I with the appropriate reagents in List II and select the correct option.

List I		List II	
P.		1.	(i) $\text{Hg}(\text{OAc})_2$ (ii) NaBH_4
Q.		2.	NaOEt
R.		3.	Et-Br
S.		4.	(i) BH_3 (ii) $\text{H}_2\text{O}_2/\text{NaOH}$

	P	Q	R	S
A.	2	3	1	4
B.	3	2	1	4
C.	2	3	4	1
D.	3	2	4	1

19. For a dilute solution containing 2.5 g of a non-volatile non-electrolyte solution in 100 g of water, the elevation in boiling point at 1 atm pressure is 2°C . Assuming concentration of solute is much lower than the concentration of solvent, the vapour pressure (mm of Hg) of the solution is (take $K_b = 0.76 \text{ K kg mol}^{-1}$)
A. 724 B. 740 C. 736 D. 718
20. Consider the cell at 25°C :
 $\text{Zn} | \text{Zn}^{2+}_{(\text{aq})} (1 \text{ M}) || \text{Fe}^{3+}_{(\text{aq})} | \text{Fe}^{2+}_{(\text{aq})} | \text{Pt}_{(\text{s})}$
The fraction of total iron present as Fe^{3+} ion at the potential of 1.500 V is
(Given : $E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}} = 0.77 \text{ V}$, $E^\circ_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V}$)
A. 0.340 B. 0.240 C. 0.597 D. 0.870

Darken your choice with HB Pencil

1. (A) (B) (C) (D)	5. (A) (B) (C) (D)	9. (A) (B) (C) (D)	13. (A) (B) (C) (D)	17. (A) (B) (C) (D)
2. (A) (B) (C) (D)	6. (A) (B) (C) (D)	10. (A) (B) (C) (D)	14. (A) (B) (C) (D)	18. (A) (B) (C) (D)
3. (A) (B) (C) (D)	7. (A) (B) (C) (D)	11. (A) (B) (C) (D)	15. (A) (B) (C) (D)	19. (A) (B) (C) (D)
4. (A) (B) (C) (D)	8. (A) (B) (C) (D)	12. (A) (B) (C) (D)	16. (A) (B) (C) (D)	20. (A) (B) (C) (D)

SOLUTIONS

1. (B) : $\frac{P^\circ - P_s}{P_s} = \frac{w}{m} \times \frac{M}{W}$

Molality = $\frac{w \times 1000}{m \times W} \Rightarrow \frac{P^\circ - P_s}{P_s} = \text{Molality} \times \frac{M}{1000}$

$\frac{100 - 98}{98} = \text{Molality} \times \frac{M}{1000}$

$\frac{2}{98} = \text{Molality} \times \frac{18}{1000}$ or Molality = 1.1 m

2. (D) : In $[\text{Fe}(\text{CN})_6]^{4-}$, Fe is present as Fe^{2+} .
Electronic configuration of Fe^{2+} is $[\text{Ar}]3d^6$. Since CN^- is a strong field ligand, when it approaches Fe^{2+} , the electrons pair up, resulting in the formation of a

low spin complex. The number of unpaired electrons becomes zero, hence the magnetic moment of the complex becomes zero.

In $[\text{Fe}(\text{CN})_6]^{3-}$, Fe is present as Fe^{3+} and the electronic configuration of Fe^{3+} is $[\text{Ar}]3d^5$. In presence of CN^- ligand, pairing of electrons takes place while a single unpaired electron is present in the e_g orbital. Due to the presence of this electron, the magnetic moment of the complex becomes

$$\mu = \sqrt{1(1+2)} = \sqrt{3} \text{ BM}$$

In $[\text{Cr}(\text{NH}_3)_6]^{3+}$, the Cr is present in +3 oxidation state and the electronic configuration of Cr^{3+} is $[\text{Ar}] 3d^3$. The pairing of electrons does not occur as electrons singly occupy all three, t_{2g} orbitals, hence, three unpaired electrons are present in the d -orbital of Cr^{3+} . So,

$$\text{Magnetic moment} = \sqrt{3(3+2)} = \sqrt{15} \text{ BM}$$

In case of $[\text{Ni}(\text{H}_2\text{O})_4]^{2+}$, Ni is present in +2 oxidation state and the electronic configuration of Ni^{2+} is $[\text{Ar}] 3d^8$. As H_2O is a weak field ligand, it does not cause pairing of electrons in d -orbital of Ni^{2+} . Hence, the number of unpaired electrons is 2.

$$\text{Magnetic moment} = \sqrt{2(2+2)} = \sqrt{8} \text{ BM}$$

Hence, the correct increasing order of magnetic moment is $\text{I} < \text{II} < \text{IV} < \text{III}$.

3. (D)

4. (D) : Larger the $-I$ effect, more is the acidity of the compound. This is because the electron withdrawing group tends to stabilize the negative charge of the phenoxide ion. Due to this, the removal of proton becomes easy.

Hence, the correct increasing order of acidity of the given phenols is $\text{II} < \text{III} < \text{IV} < \text{I}$.

5. (B) : For the given cell,

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.059}{n} \log \frac{[\text{Sn}^{2+}]}{[\text{Pb}^{2+}]}$$

$$E_{\text{cell}}^{\circ} = E_{\text{cathode}}^{\circ} = E_{\text{anode}}^{\circ} = -0.126 - (-0.136) = 0.010 \text{ V}$$

$$E_{\text{cell}} = 0.010 - \frac{0.059}{2} \log \frac{[\text{Sn}^{2+}]}{[\text{Pb}^{2+}]}$$

At equilibrium $E_{\text{cell}} = 0$

$$0 = 0.010 + 0.0295 \log \frac{[\text{Pb}^{2+}]}{[\text{Sn}^{2+}]}; -\frac{0.010}{0.0295} = \log \frac{[\text{Pb}^{2+}]}{[\text{Sn}^{2+}]}$$

$$-0.339 = \log \frac{[\text{Pb}^{2+}]}{[\text{Sn}^{2+}]} \Rightarrow \frac{[\text{Pb}^{2+}]}{[\text{Sn}^{2+}]} = 0.458$$

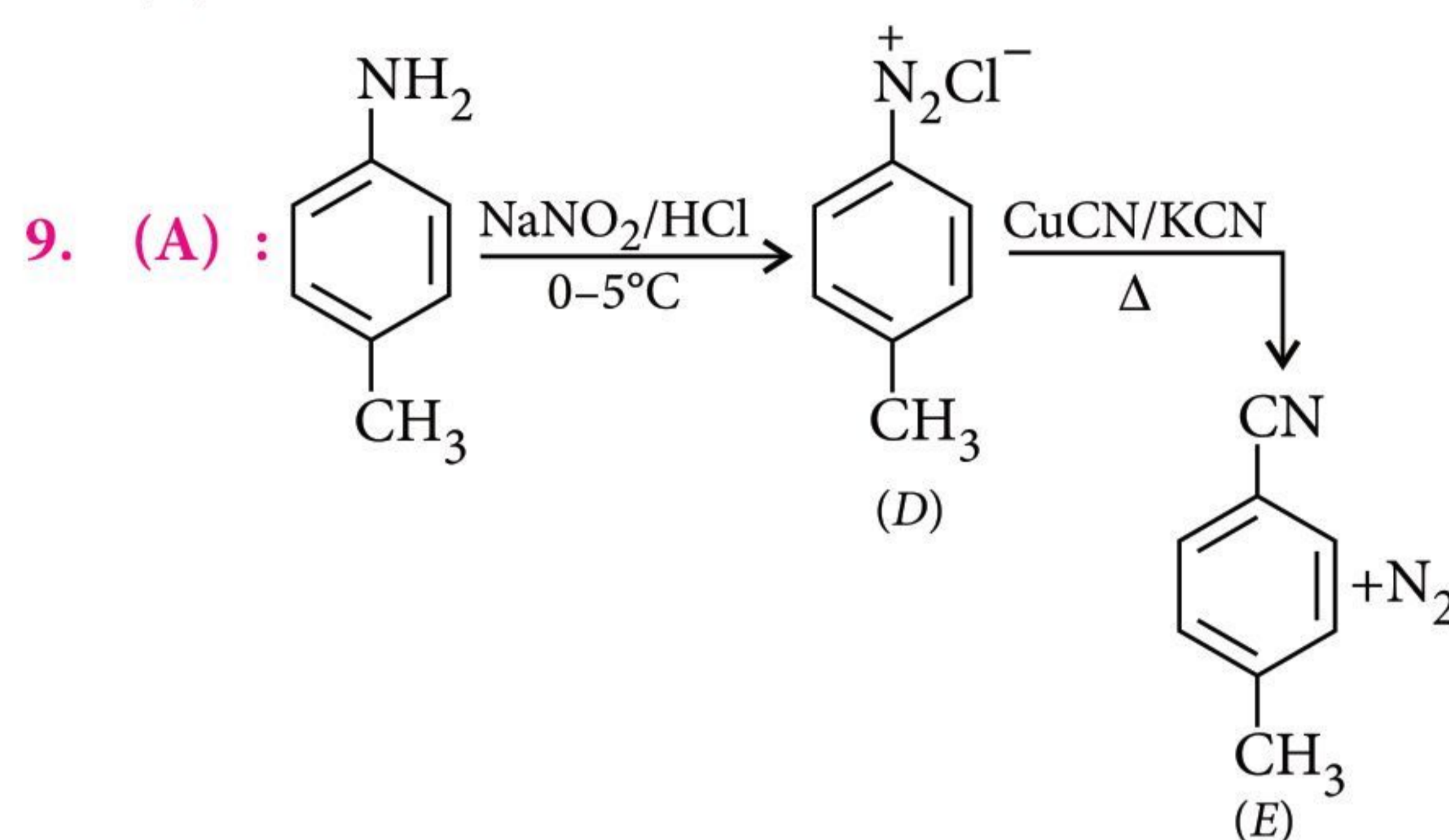
If $\frac{[\text{Pb}^{2+}]}{[\text{Sn}^{2+}]} > 0.458$ (forward reaction will take place)

If $\frac{[\text{Pb}^{2+}]}{[\text{Sn}^{2+}]} < 0.458$ (backward reaction will take place)

6. (C)

7. (B)

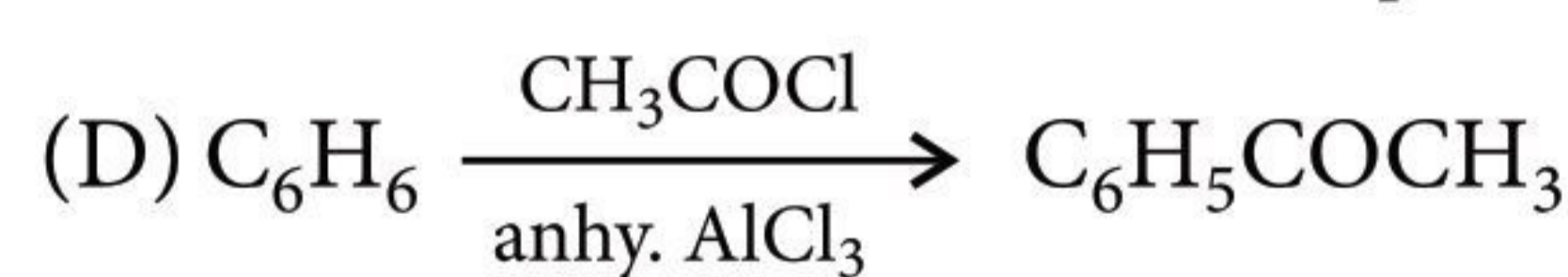
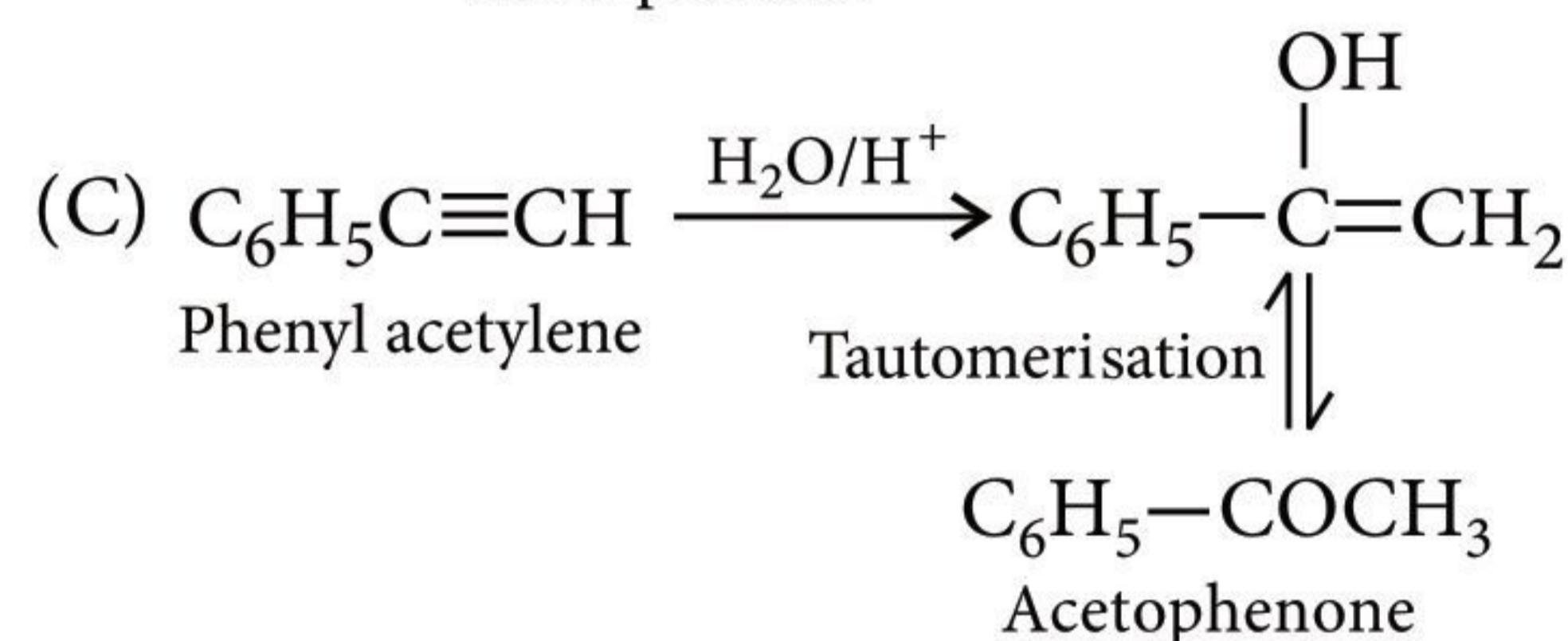
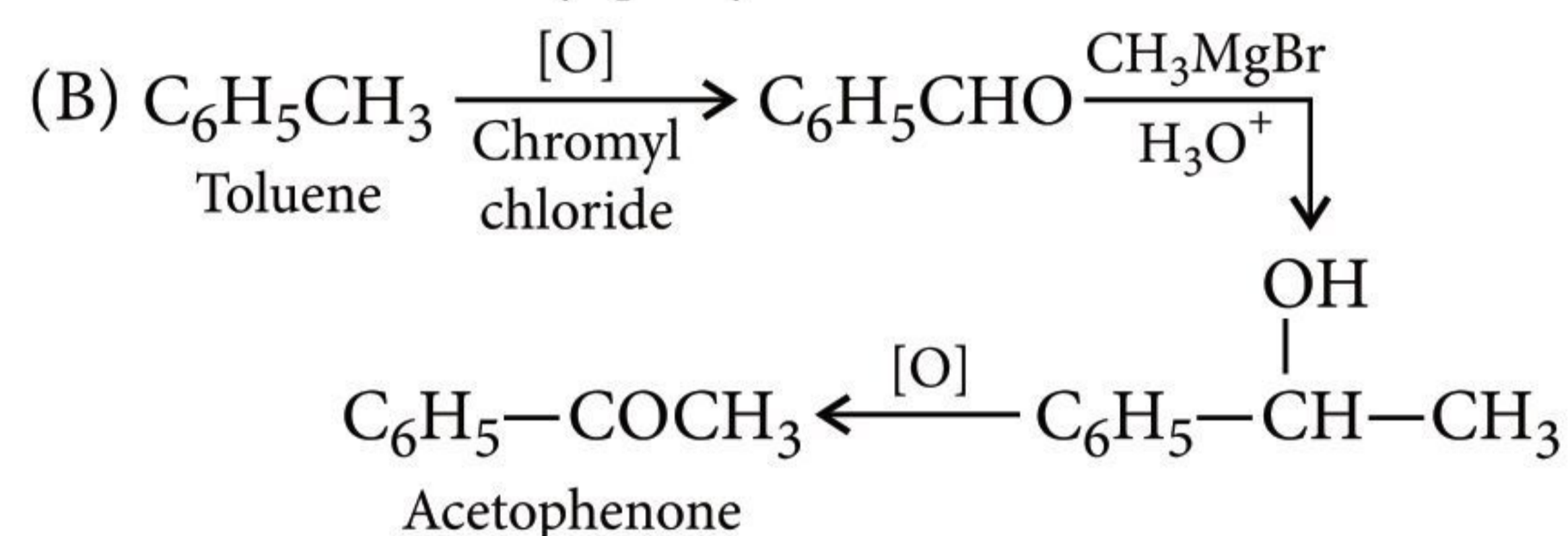
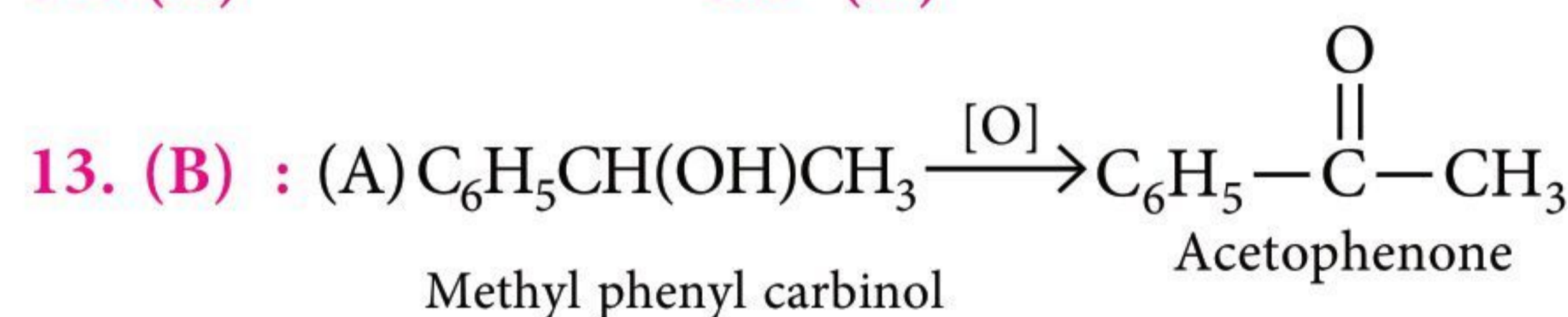
8. (C)



10. (D) : Deficiency of vitamin A causes xerophthalmia and deficiency of vitamin D causes rickets.

11. (A)

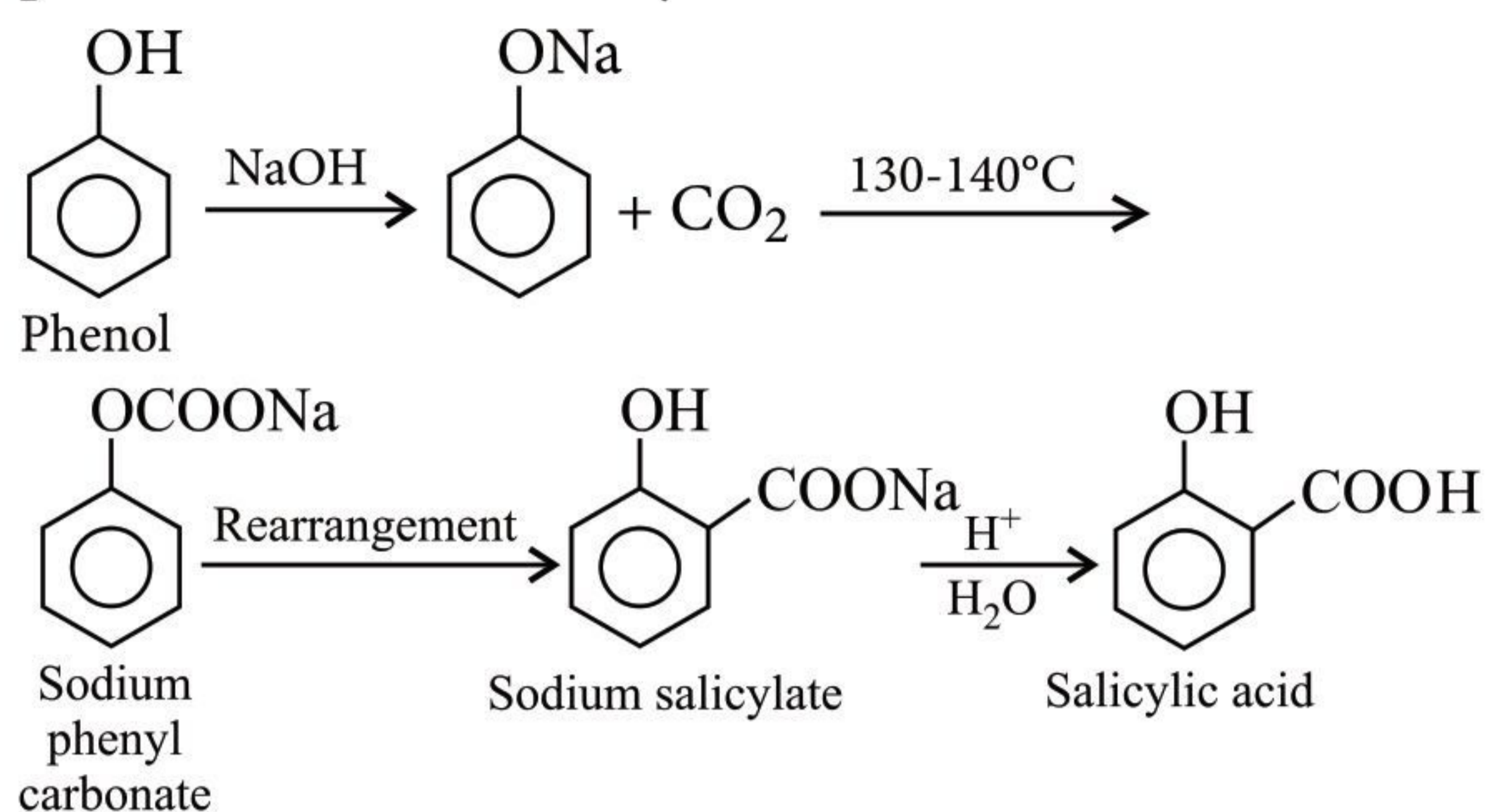
12. (D)



MONTHLY TEST DRIVE CLASS XI ANSWER KEY

1. (b)	2. (a)	3. (c)	4. (a)	5. (b)
6. (a)	7. (c)	8. (b)	9. (b)	10. (d)
11. (d)	12. (b)	13. (a)	14. (d)	15. (c)
16. (b)	17. (b)	18. (b)	19. (b)	20. (a,c)
21. (a,c)	22. (a,b)	23. (b,d)	24. (100)	25. (1)
26. (6)	27. (a)	28. (d)	29. (d)	30. (d)

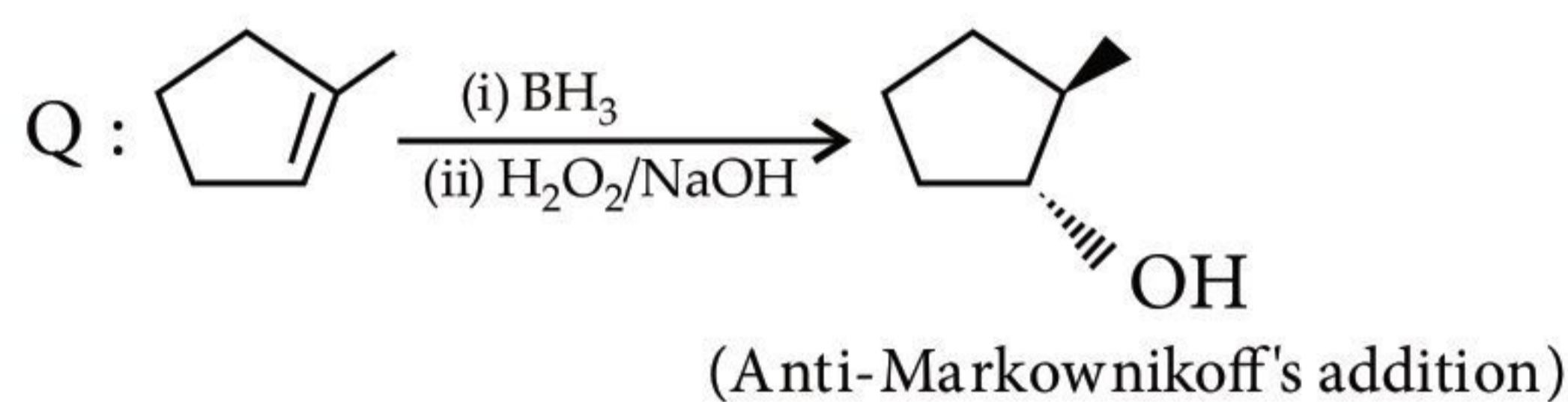
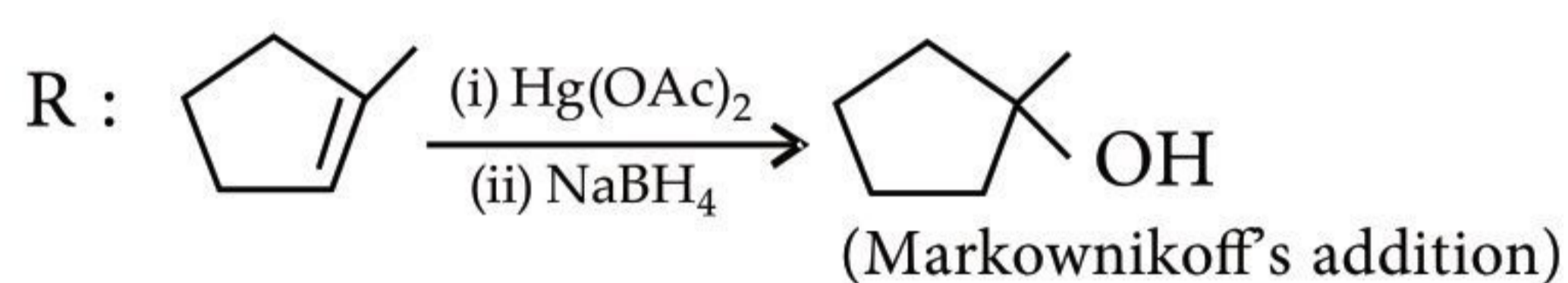
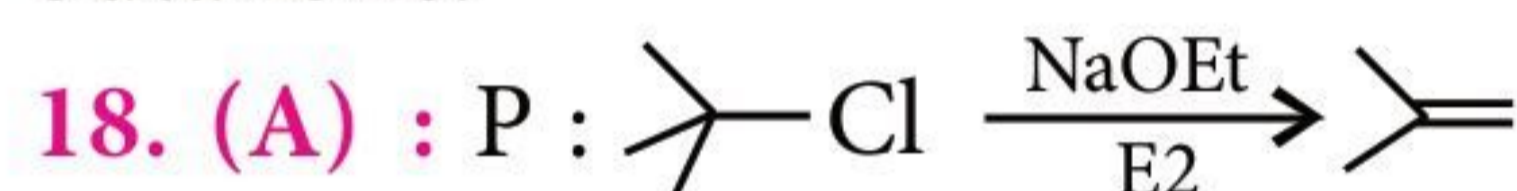
14. (C) : The reaction of phenol with NaOH and CO₂ is known as Kolbe-Schmidt or Kolbe's reaction. The product formed is salicylic acid.



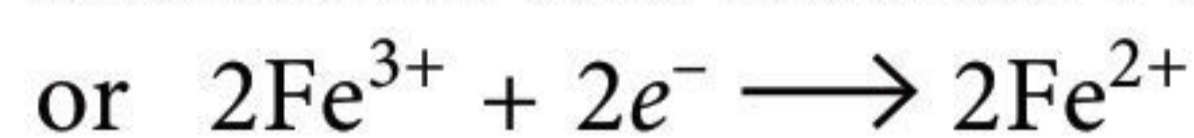
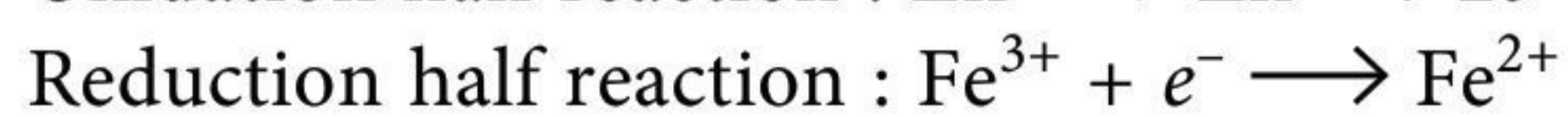
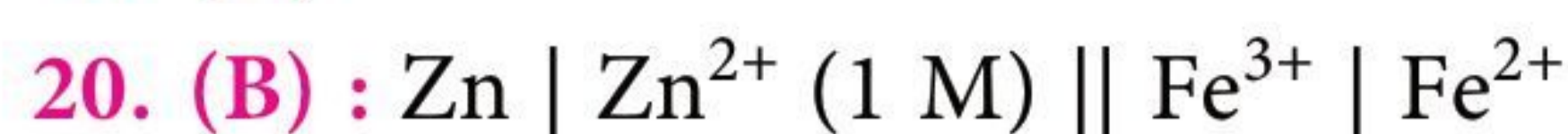
15. (B)

16. (A)

17. (B) : Since the compound does not reduce Fehling's solution but forms crystalline bisulphite derivative hence it is a ketone. Since it gives iodoform test, the compound can be a methyl ketone. Hence, the possible compounds can be 2-pentanone and 3-methyl-2-butanone.

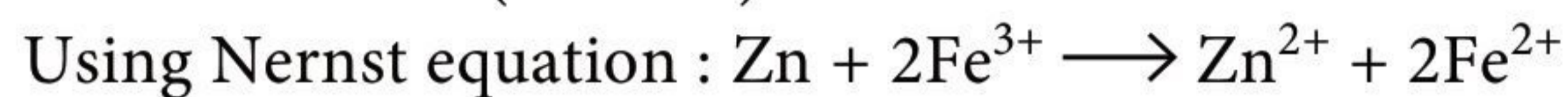


19. (A)



$$E_{\text{cell}}^\circ = E_{\text{Fe}^{3+}|\text{Fe}^{2+}}^\circ - E_{\text{Zn}^{2+}|\text{Zn}}^\circ$$

$$= 0.77 \text{ V} - (-0.76 \text{ V}) = 1.53 \text{ V}$$



$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.059}{n} \log \frac{[\text{Zn}^{2+}][\text{Fe}^{2+}]^2}{[\text{Zn}][\text{Fe}^{3+}]^2}$$

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.059}{2} \log \frac{[1][\text{Fe}^{2+}]^2}{[1][\text{Fe}^{3+}]^2}$$

$$1.5 = 1.53 - \frac{0.059}{2} \log \frac{[\text{Fe}^{2+}]^2}{[\text{Fe}^{3+}]^2}$$

$$1.5 = 1.53 - \frac{0.059}{2} \times 2 \log \frac{[\text{Fe}^{2+}]}{[\text{Fe}^{3+}]}$$

$$\log \left[\frac{[\text{Fe}^{2+}]}{[\text{Fe}^{3+}]} \right] = \frac{0.03}{0.059} = 0.5$$

$$\left[\frac{[\text{Fe}^{2+}]}{[\text{Fe}^{3+}]} \right] = \text{Antilog}(0.5) = 3.16 ; \left[\frac{[\text{Fe}^{3+}]}{[\text{Fe}^{2+}]} \right] = \frac{1}{3.16}$$

Fraction of total iron present as Fe³⁺ ion

$$= \frac{[\text{Fe}^{3+}]}{[\text{Fe}^{2+}] + [\text{Fe}^{3+}]} = \frac{1}{1 + 3.16} = 0.240$$

For other sections/subjects please refer to
Physics For You and Biology Today



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- 1 Make an Appropriate Use of Time Tool :** Get to know your syllabus, make a timetable for various subjects, giving more time to the subjects you are weak in.
- 2 Keep Revising at Regular Intervals :** Revise all the topics at regular intervals, as it is imperative for any exam preparation. It helps in remembering the facts, figures, topics and methodologies already covered by you and will surely increase your confidence.
- 3 Practice Previous Years' Papers :** Practice as many previous years' question papers as possible, as it gives a fair idea about the level of difficulty and pattern of questions.
- 4 Study with Good Resource Books :** A good resource book is like a good 'Mentor'. Prepare for Olympiads with right guidance as well as with the best trusted resources.
- 5 Stay Motivated :** Last but not the least, always stay positive and focused. Believe in Yourself!



CONCEPT BOOSTER

Hello students! Another festive season has just ended. Hope you all had a nice time spent. Now its time to gear up for the upcoming examinations. The most important part is how to prepare and how to keep things in mind. The key to success is study regularly and what you study just pen down that. Here, in this article, I have covered some 'organic reaction mechanisms and their pathways.' Stay updated for upcoming exams with Chemistry Today !

*Arunava Sarkar

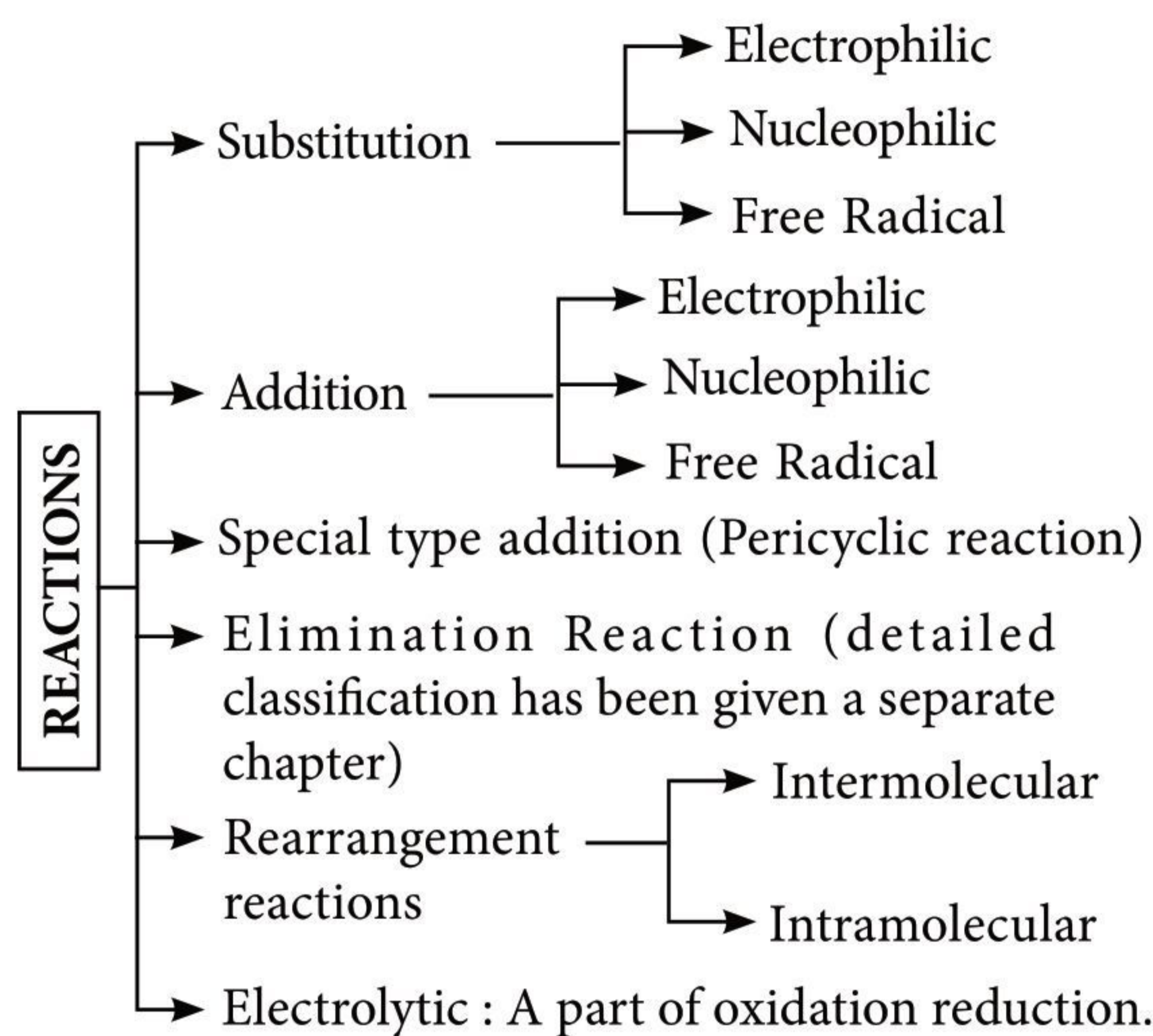
Organic Reaction Mechanisms and Their Pathways

Organic reaction mechanisms are basically a dynamic picture that how a reaction is carried out. For a reaction, bond breaking and the bond forming are the key steps. A mechanism demonstrates the bond making and breaking sequences taking place one by one. But this is to be remembered that no mechanism is known to us completely. Then how do we write the mechanism for a chemical reaction? This is basically a logical work done after seeing the net chemical change. Basically, a mechanism includes the following :

1. Which bonds are broken and in what sequence
2. How many steps are involved in the reaction
3. Relative position of all the atoms (among reactants, reagents and solvents)
4. Relative rate of every step
5. Energy of the system

Based on the facts stated above, we always try to put forward a reaction mechanism and we can happily say that in most of the cases, it is done successfully and with great accuracy.

You know what, if a reaction is carried out then the first two things which are required are substrate and attacking reagent. An attacking reagent may be a nucleophile or an electrophile. A group may depart from the reaction zone. This group is known as leaving group. A leaving group may be a nucleofuge (*i.e.*, leaving with an electron pair) or it may be an electrofuge (*i.e.*, leaving without an electron pair). A bond usually breaks down either homolytically or heterolytically. We may classify reactions as follows:



You can understand that the area of organic reactions is so vast that to frame them within a small jurisdiction will be impossible and a foolish job. Basically, I have given a bit idea about the types of organic reactions. In fact, maximum reactions may be a combination of above reactions.

Hammond Postulate and Its Applications

The lifespan of transition state is very small, based on some experimental data, Hammond postulate was proposed which somehow helps us to get an idea about the geometry of the transition state. According to this postulate, "for a single step reaction, the transition state will be more similar to that species which is more similar to it as per the energy or free energy is concerned". For an exothermic reaction, transition state will be more

*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

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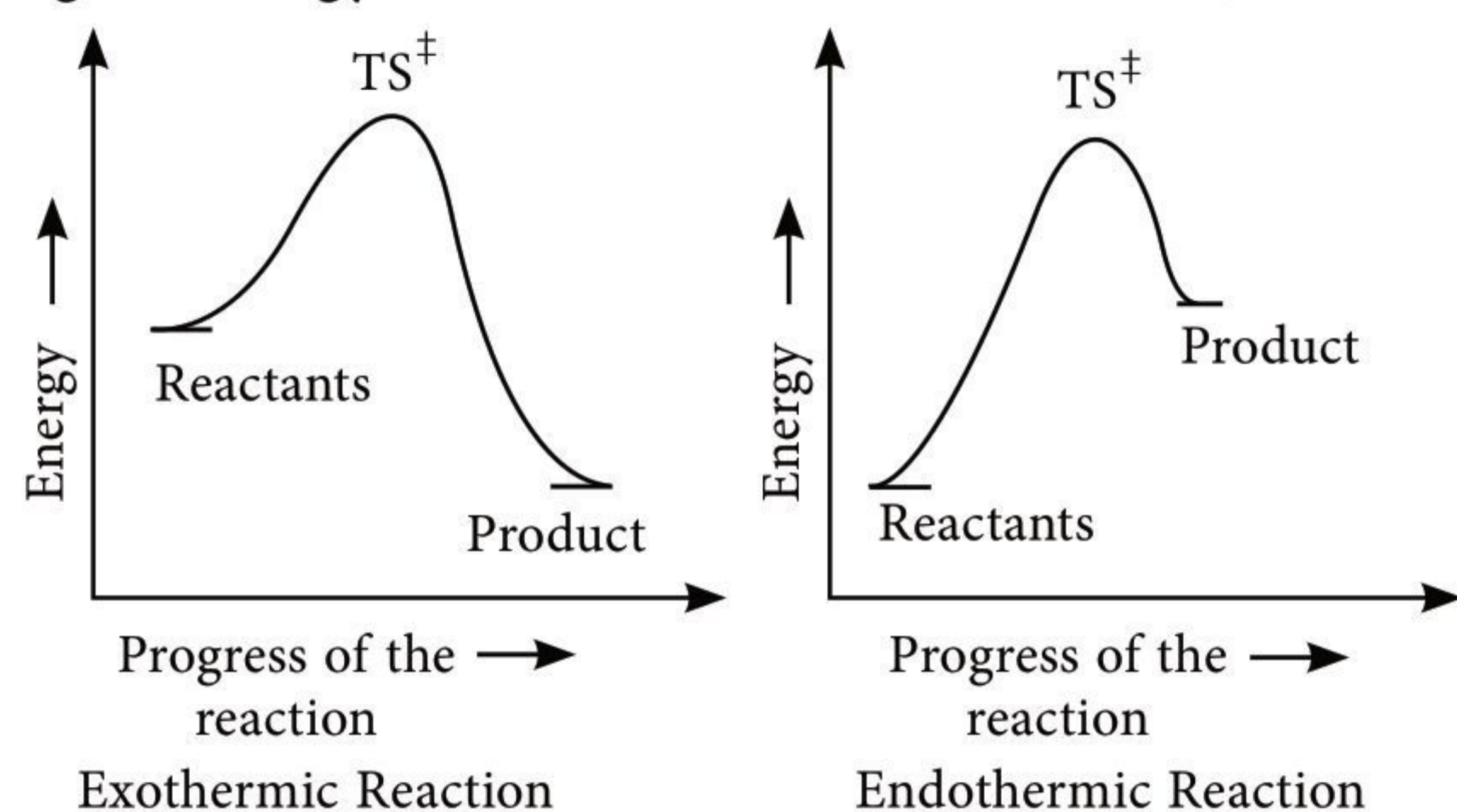


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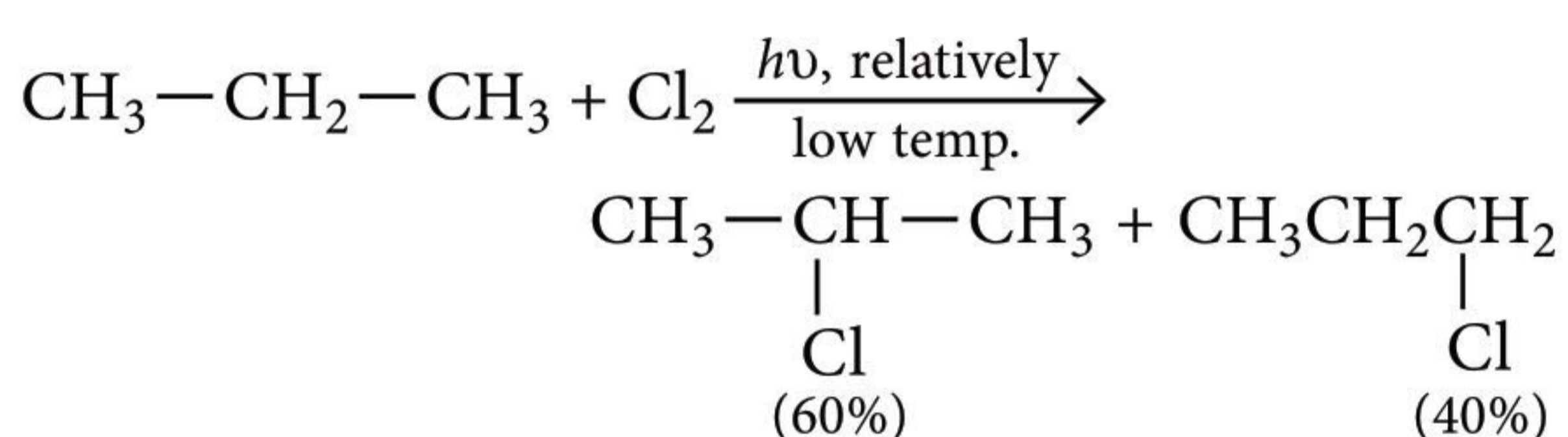
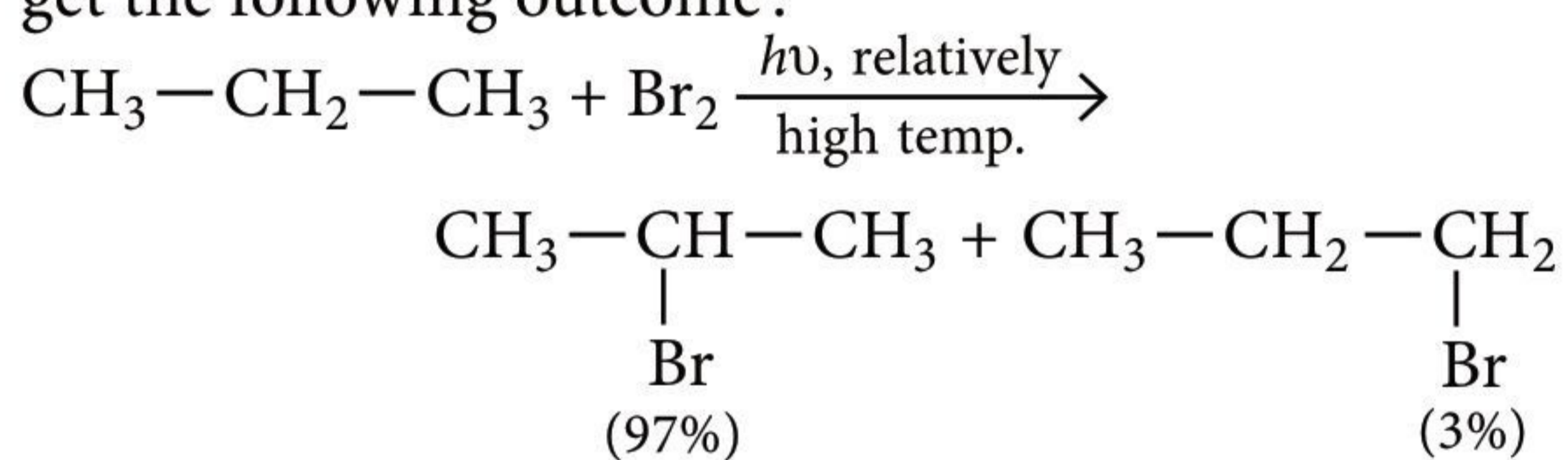
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similar to the reactants (as here reactants are having higher energy than that of the products). On the other hand, for an endothermic reaction, transition state will be more similar to the products (as products are having higher energy than that of the reactants here).



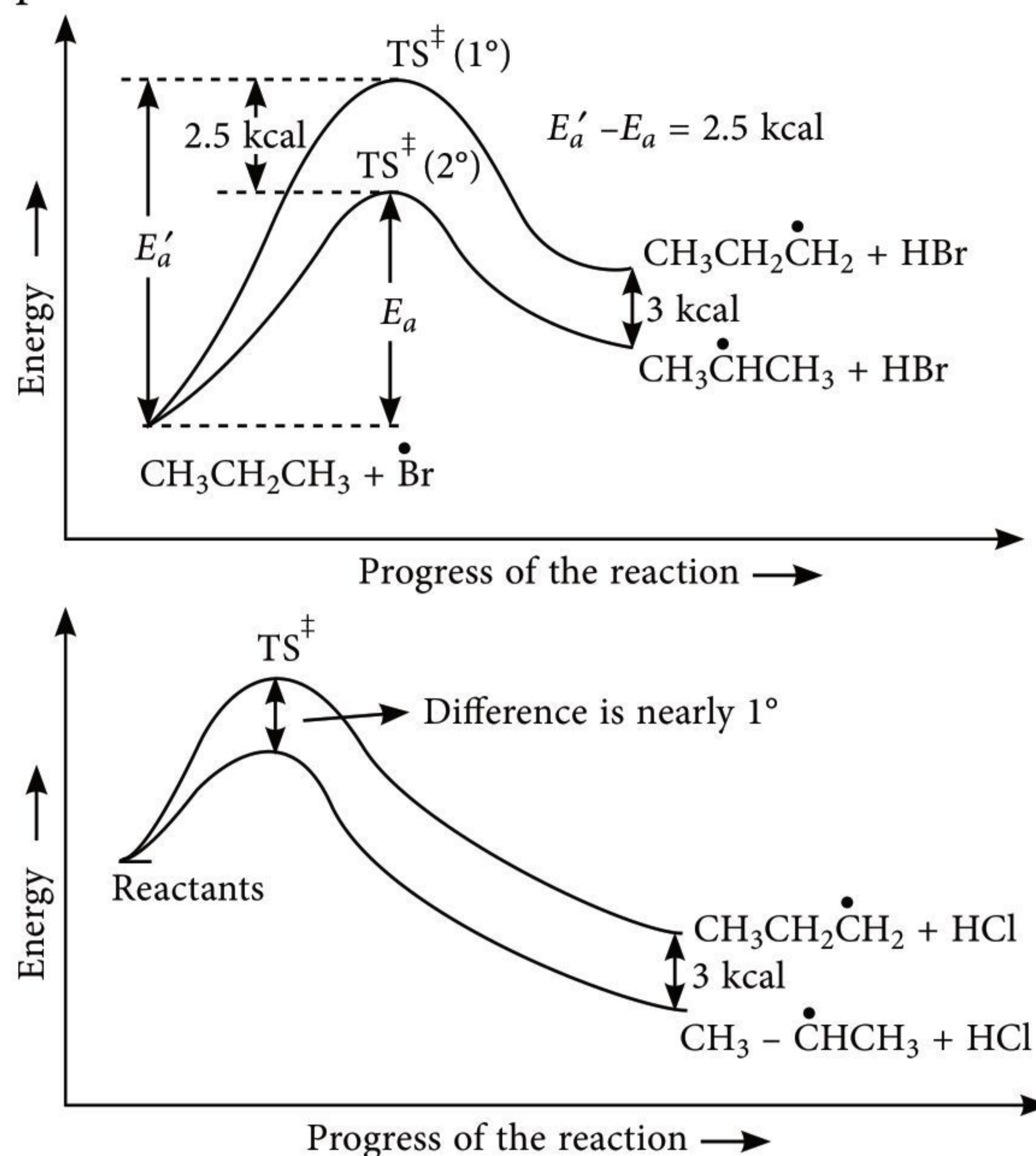
Application (Selectivity of Bromination Over Chlorination).

Hammond postulate is supported by many facts and observations. For example, when bromination and chlorination is carried out for propane separately we get the following outcome:



Now, both the reactions pass via free radical mechanism. If 2° free radical is more stable than 1° free radical then why is this differentiation found? This can be answered based on Hammond's postulate. Basically, for both of the above reactions, the rate determining step (RDS) is the abstraction of hydrogen atom by the bromine or chlorine radical. For bromination, this step is endothermic and for chlorination, this step is exothermic. This is why in the case of bromination, we've product like transition state and this transition state has a great amount of radical character. On the other hand, in the case of chlorination, we've reactant like transition state which has very small amount of radical character. This is why in case of bromination, energy difference between the two transition states containing 1° and 2° free radicals is high but this is low in case of chlorination. This difference is reflected in the amount of products obtained. Lower

energy transition state gives large amount of major product.

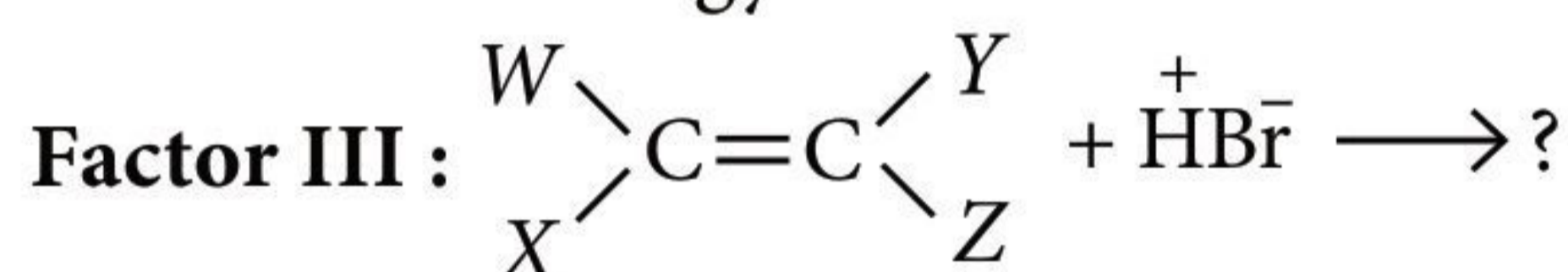


Notable point is that ultimately formed products have some difference in their energies (difference is about 3 kcal).

Rate of a reaction basically depends on three main factors:

Factor I : Number of collisions taking place between the participating reactant molecules within a proper period of time.

Factor II : Reactant molecules must be supplied with adequate amount of energy so that the reactant molecules can cross the energy barrier.



Now, think where should H^+ attack on the reactant? W? X? Y? or Z? Answer is none of these. For this reaction to be successful H^+ should attack on the double bond. What I want to focus is that reacting molecules should always maintain a proper orientation for the successful reaction.

MONTHLY TEST DRIVE CLASS XII ANSWER KEY

- | | | | | |
|-------------|-----------|-------------|---------|-----------|
| 1. (d) | 2. (a) | 3. (d) | 4. (b) | 5. (b) |
| 6. (c) | 7. (b) | 8. (a) | 9. (a) | 10. (c) |
| 11. (c) | 12. (a) | 13. (d) | 14. (c) | 15. (c) |
| 16. (b) | 17. (d) | 18. (c) | 19. (b) | 20. (a,c) |
| 21. (a,b,d) | 22. (c,d) | 23. (a,b,d) | 24. (5) | 25. (5) |
| 26. (100) | 27. (d) | 28. (a) | 29. (c) | 30. (d) |

Overall rate of reaction

$$= \left(\frac{\text{No. of collisions taking place per unit time}}{\text{Fraction of molecules with sufficient energy}} \right) \times \left(\frac{\text{Fraction of molecules with proper orientation}}{\text{Fraction of molecules with sufficient energy}} \right)$$

For the proper orientation, entropy of activation must be considered which is basically the difference in entropy between the transition state and the reactants. Please remember that in order to get a proper orientation, a molecule has to select one conformation out of many possible conformations. So, there is always a loss of entropy (ΔS^\ddagger is -ve).

Thermodynamics versus Kinetic Control of a Chemical Reaction

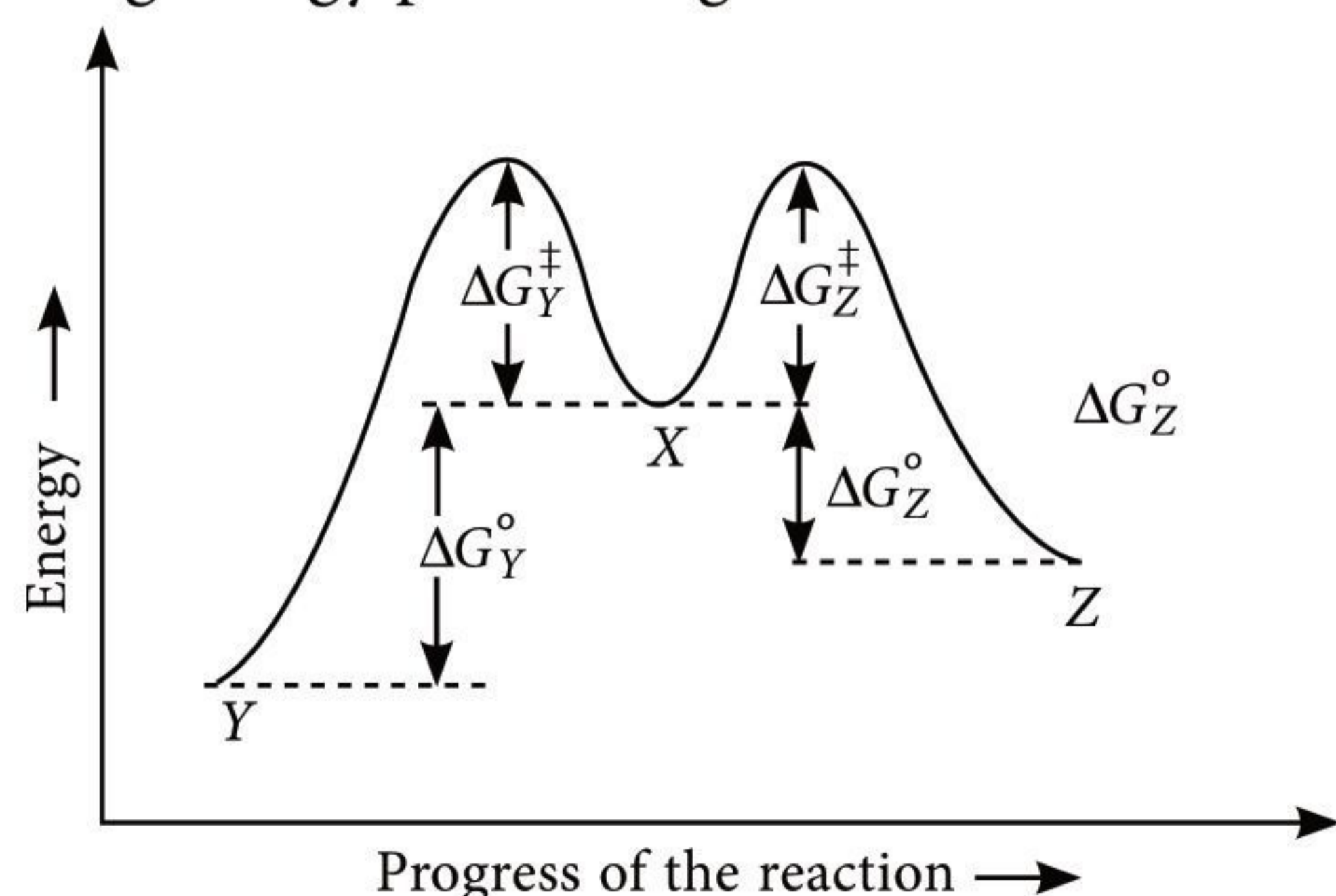
I will try to make a very easy approach to discuss this topic. Suppose, X is a reactant which can give you two products Y and Z out of which Y is thermodynamically stable i.e., Y is a thermodynamic product whereas Z is formed fast i.e., Z is a kinetic product. This means, for the formation of Z from X, energy barrier is low but it is high in case of the formation of Y. Now, the problem is whether the reaction is reversible or irreversible.

Case I : Reaction is irreversible.

Kinetic product will be the major product here, as this product is formed first. Before the production of Y, formation of Z is done and as reaction is irreversible, Z can't go back to X.

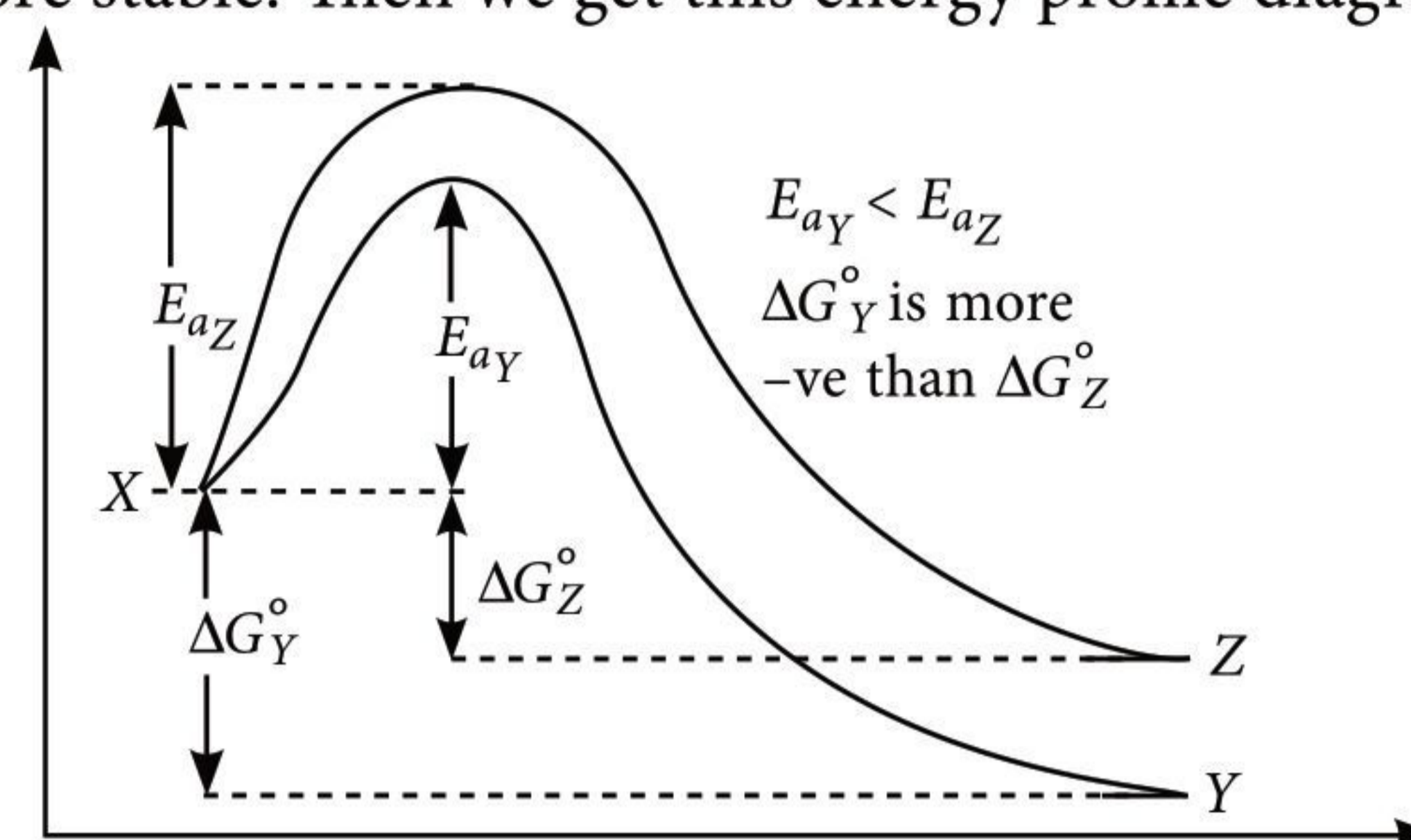
Case II : Reaction is reversible.

Y will be the major product. Why? because everyone wants stability. As the reaction is attaining equilibrium, therefore, initially fast formed and first formed Z will revert back to X which now gives thermodynamically more stable Y. As per the above two cases, we get the following energy profile diagram.

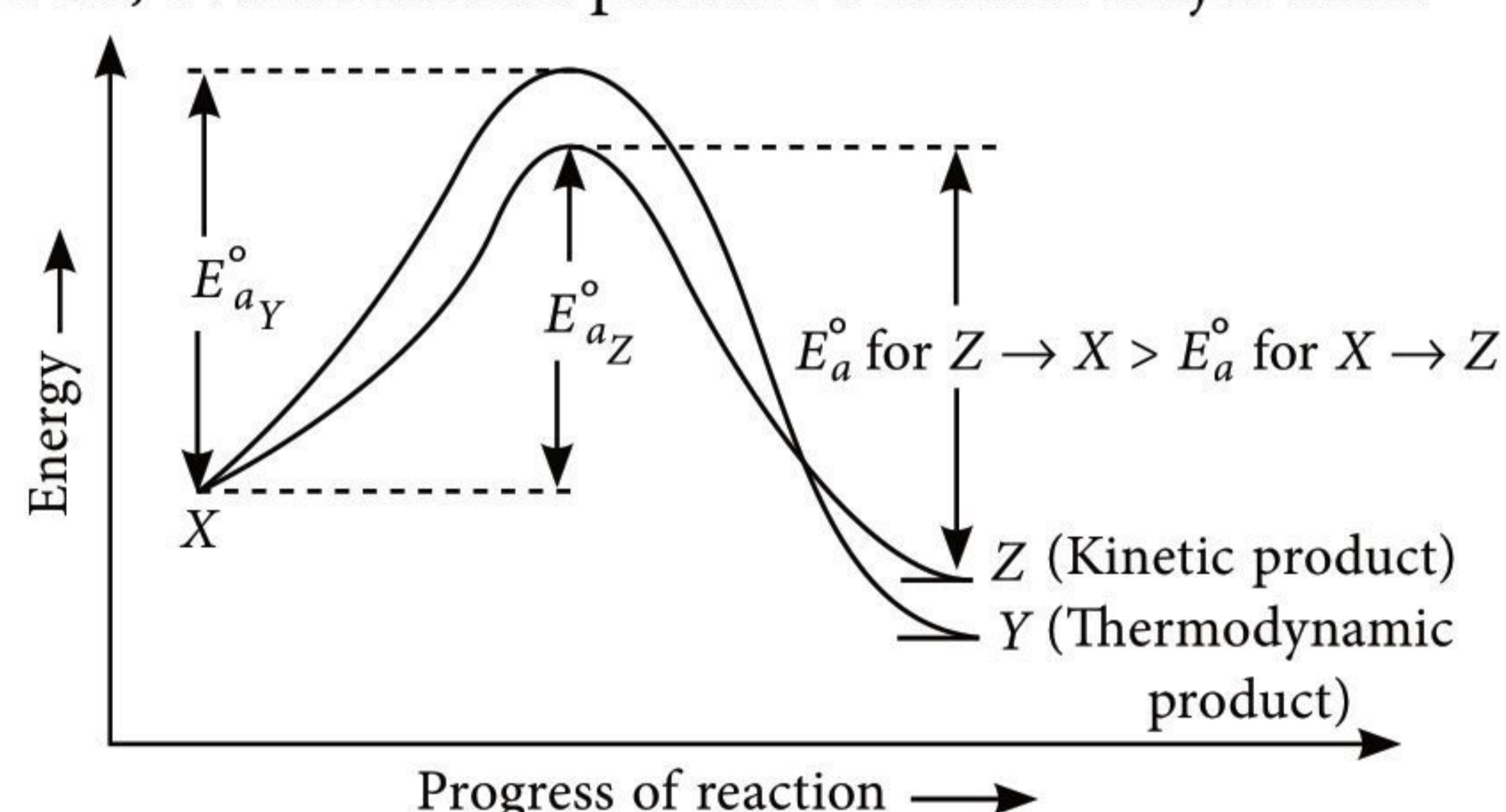


Frankly speaking, if a reaction is such that the formation of more stable product has the lower activation energy,

then there is no problem at all, as this is the ideal case. At this time, formation of the product is accompanied or supported by both the kinetic as well as thermodynamic requirements. Suppose, formation of Y from X has lower energy of activation and Y is also thermodynamically more stable. Then we get this energy profile diagram.



At low temperature, as for the formation of Y, required activation energy is higher than that of the activation energy required for the formation of Z (kinetic product) therefore, X manages to go to Z, but X can't manage to go to Y. Of course at that time there is no question of forming X from Y. Z also can't go back to X as whatever activation energy is required to go to Z from X, more than that activation energy is required to go to X from Z. So, overall kinetic product becomes major here.



So,
$$\text{Y (Thermodynamic product)} \xrightleftharpoons{\text{slow}} \text{X} \xrightleftharpoons{\text{fast}} \text{Z (Kinetic product)}$$

At high temperature, all reactions become reversible as at high temperature, energy barrier has nothing to do.

So,
$$\text{Y (Thermodynamic product)} \xrightleftharpoons{\text{fast}} \text{X} \xrightleftharpoons{\text{fast}} \text{Z (Kinetic product)}$$

At moderate temperature, at this state, X will form both Y and Z.

X will give the thermodynamically more stable product. i.e., Y.

So,
$$\text{Y (More stable)} \xrightleftharpoons{\text{fast}} \text{X} \xrightleftharpoons{\text{fast}} \text{Z}$$



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Unit 3

States of Matter | Thermodynamics

STATES OF MATTER

INTERMOLECULAR FORCES

Intermolecular forces are the forces of attraction or repulsion between atoms and molecules and these forces influence physical properties and sometimes chemical properties.

Intermolecular Forces of Attraction

Types of Forces	Description
Dipole-induced dipole interaction	Forces between molecules having permanent dipole moment and molecule lacking permanent dipole moment.
Dipole-dipole interaction	Forces that exist between polar molecules where the positive end of one molecule attracts the negative end of another molecule.
London- dispersion forces	Forces that exist between molecules as a result of positive nuclei of one molecule attracting the electrons of another molecule.
Hydrogen bonding	Forces that exist between molecules that have a hydrogen atom bonded to a highly electronegative atom such as oxygen, nitrogen or fluorine.

Intermolecular Forces vs Thermal Energy

- Intermolecular forces tend to keep the particles (atoms or molecules) together. Thermal energy of a substance tends to keep its particles away from each other. Thus the two compete with each other. The three states of matter, are the result of competition between intermolecular forces and thermal energy.
- The particles in solids have very strong intermolecular forces and very little kinetic energy or thermal energy.
- The particles in any liquid have more kinetic energy or thermal energy than in solids.
- The particles in gases have very large kinetic energy or thermal energy and negligible intermolecular forces.
- **Melting point** : The melting point of a solid substance depends on the nature of bonding in it. A solid having ionic interactions has high melting point. Thus, ionic solids have higher melting point. Molecular solids have lower melting point.
- **Boiling point** : Boiling point depends upon the strength of the cohesive forces in any liquid. Liquids having stronger intermolecular interactions, in general, will have higher boiling point. Hydrogen bonding raises the boiling point of a liquid.

GASEOUS STATE

Main characteristics of gaseous state are :

- Highly compressible.
- Exert pressure equally in all directions.
- Weak intermolecular forces.

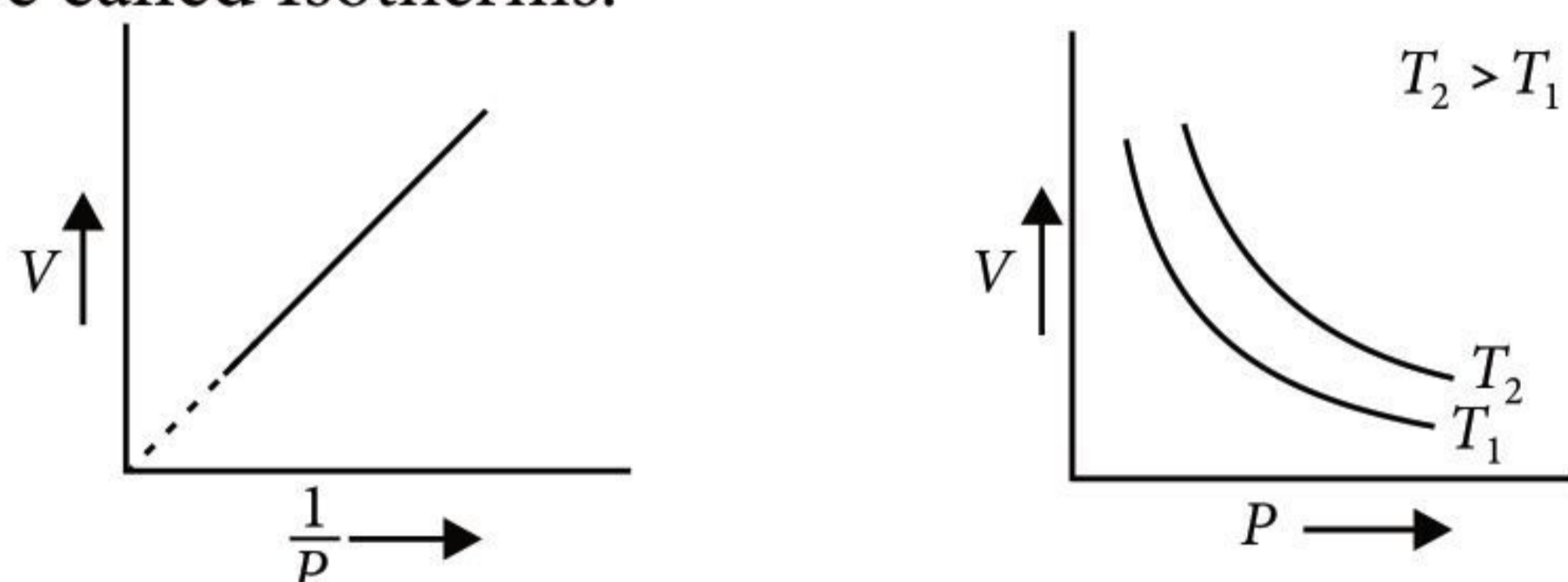
- Much lower density than the solids and liquids.
- No definite shape and volume, assume volume and shape of the container.
- Intermix evenly and completely in all proportions without any mechanical aid.

GAS LAWS

- **Boyle's Law:** $V \propto \frac{1}{P}$ or $PV = \text{constant}$ (at constant temperature)

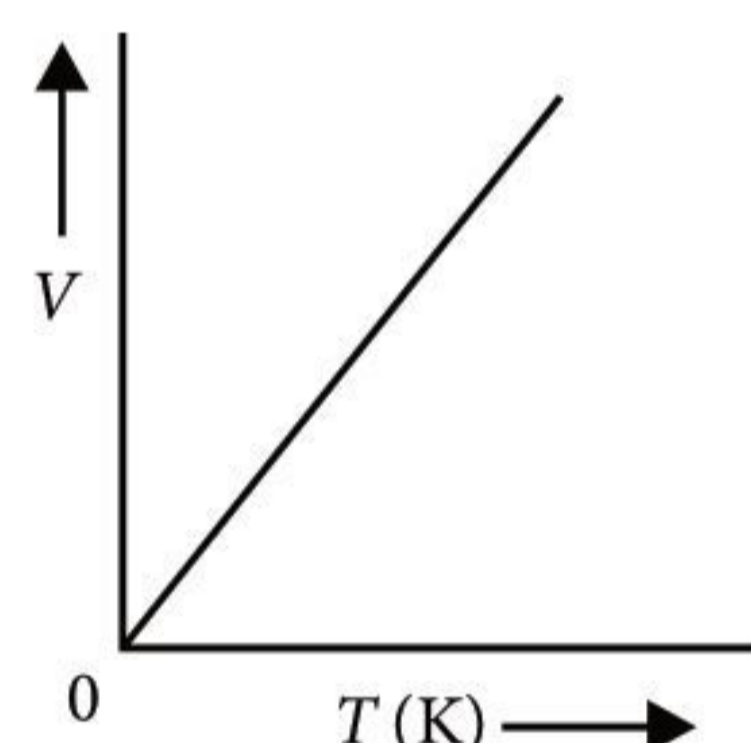
$$\text{or } P_1 V_1 = P_2 V_2$$

The plots drawn at constant temperature for a gas are called Isotherms.



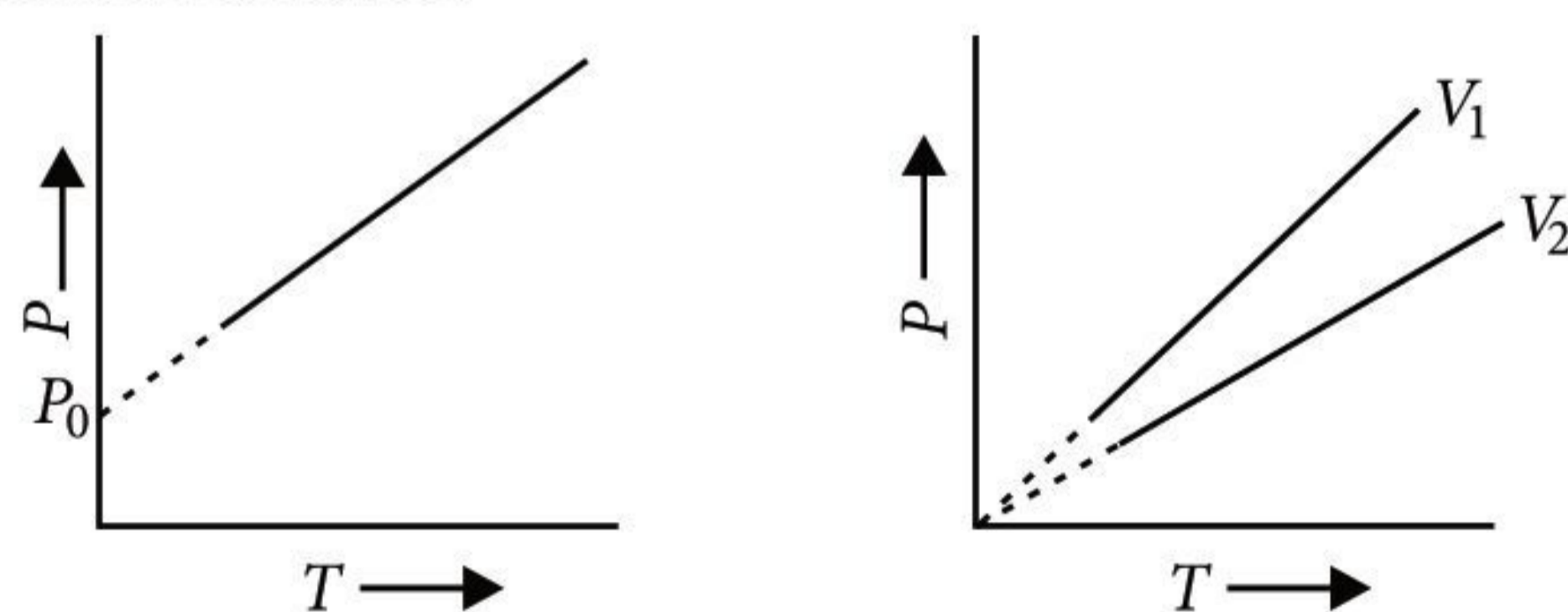
- **Charles' Law:** $V \propto T$ or $\frac{V}{T} = \text{constant}$ or $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (at constant pressure)

Graphs between V and T at constant pressure are called Isobars.



- **Gay Lussac's Law:** $P \propto T$ or $\frac{P}{T} = \text{constant}$ or $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (at constant volume)

The plots drawn at constant volume for a gas are called Isochores.



- **Avogadro's Law:** $V \propto N$ or $V \propto n$ (N, n stand for number of molecules and moles)

- **Graham's Law of Diffusion of Gases**

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} \text{ or } \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

M_1 and M_2 are molecular weights as M.W. = 2 × V.D.

IDEAL GAS EQUATION

- **Ideal Gas Equation:** It is the combination of three laws, i.e., Boyle's, Charles' and Avogadro's.

$$PV = nRT$$

(R is the universal gas constant or molar gas constant.)

- Value of R :
 - 0.0821 litre atm K⁻¹ mol⁻¹
 - 8.314×10^7 erg K⁻¹ mol⁻¹ (C.G.S. unit)
 - 8.314 Joule K⁻¹ mol⁻¹ (M.K.S. unit)
 - $1.987 \approx 2$ calorie K⁻¹ mol⁻¹
 - 82.1 cm³ atm K⁻¹ mol⁻¹
 - 0.083 bar dm³ K⁻¹ mol⁻¹

Dalton's Law of Partial Pressures

$$P_{\text{mix}} = p_1 + p_2 + p_3 + \dots$$

$$p_1 = P_{\text{mix}} \times \text{mole fraction of gas 1.}$$

i.e., partial pressure = total pressure × mole fraction

KINETIC GAS EQUATION

$$PV = \frac{1}{3} mnu^2$$

where, P = pressure of gas

V = volume of gas

m = mass of one molecule of gas

n = number of molecules of gas

u = root mean square speed of molecules

- **Relationship between average kinetic energy and absolute temperature**

$$K.E. = \frac{3}{2} KT, \text{ where, } \left(K = \frac{R}{N} \right) = \text{Boltzmann constant}$$

- **Different Types of Molecular Speed**

Average speed	Root mean square speed	Most probable speed
$u_{av} = \sqrt{\frac{8RT}{\pi M}}$	$u_{rms} = \sqrt{\frac{3RT}{M}}$	$u_{mp} = \sqrt{\frac{2RT}{M}}$

- **Relation between u_{mp} , u_{av} , u_{rms}**

$$u_{mp} : u_{av} : u_{rms} = \sqrt{\frac{2RT}{M}} : \sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{3RT}{M}}$$

$$= 1 : 1.128 : 1.224$$

$$u_{av} = 0.921 \times u_{rms}; u_{mp} = 0.816 \times u_{rms}$$

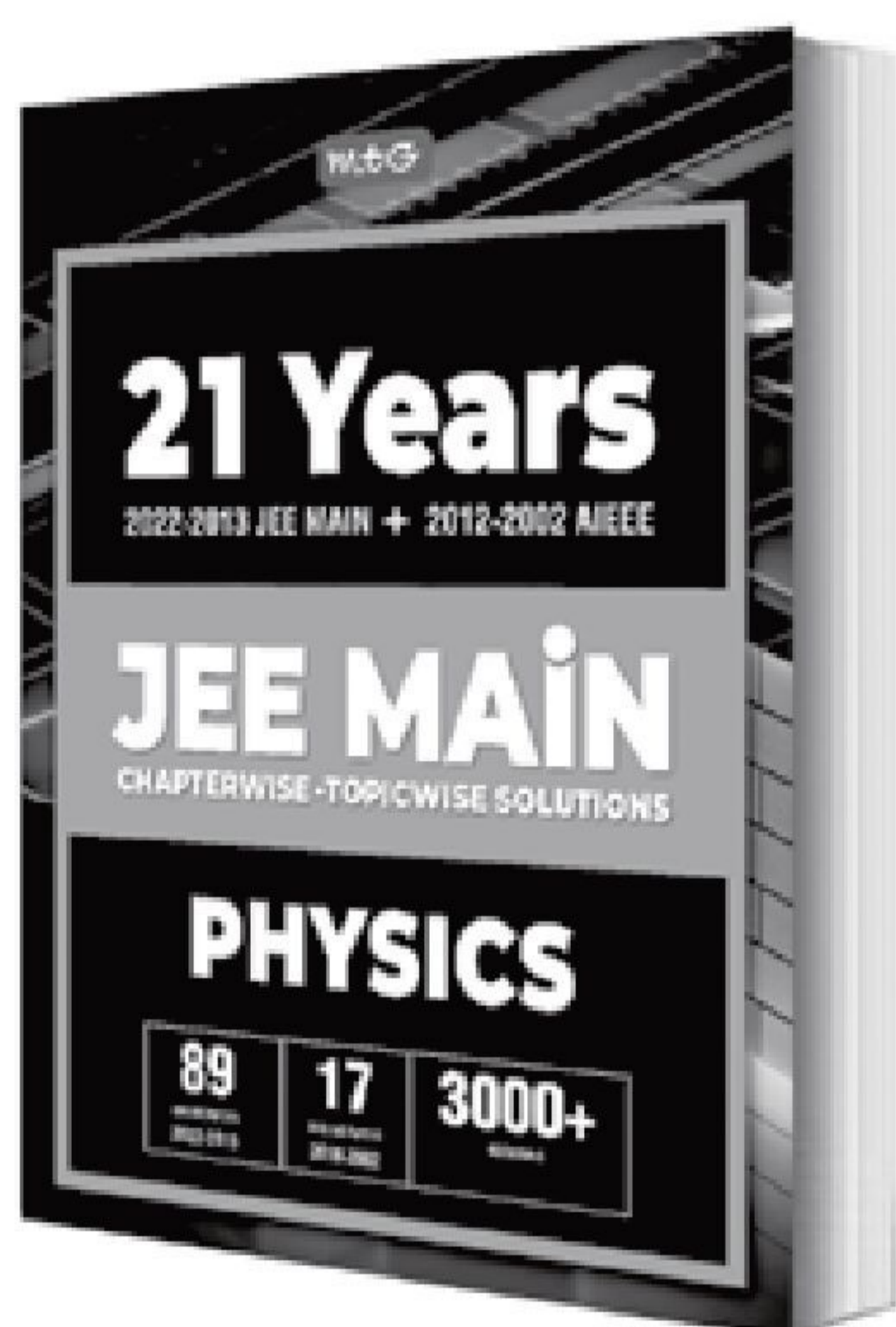
Thus, $u_{rms} > u_{av} > u_{mp}$.

KINETIC MOLECULAR THEORY OF GASES

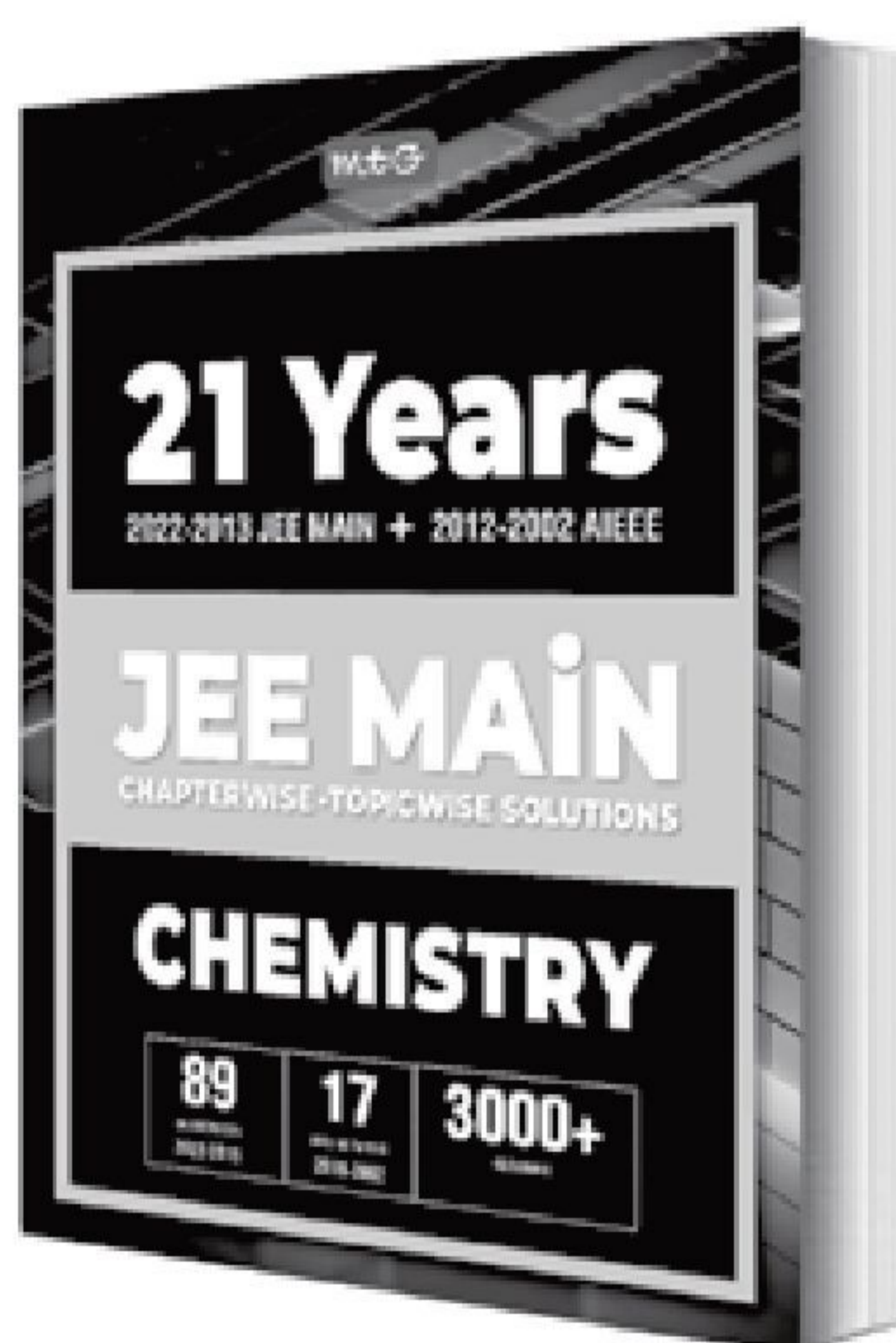
- The gas laws were based on simple experimental facts hence, a theoretical proof or derivation for the

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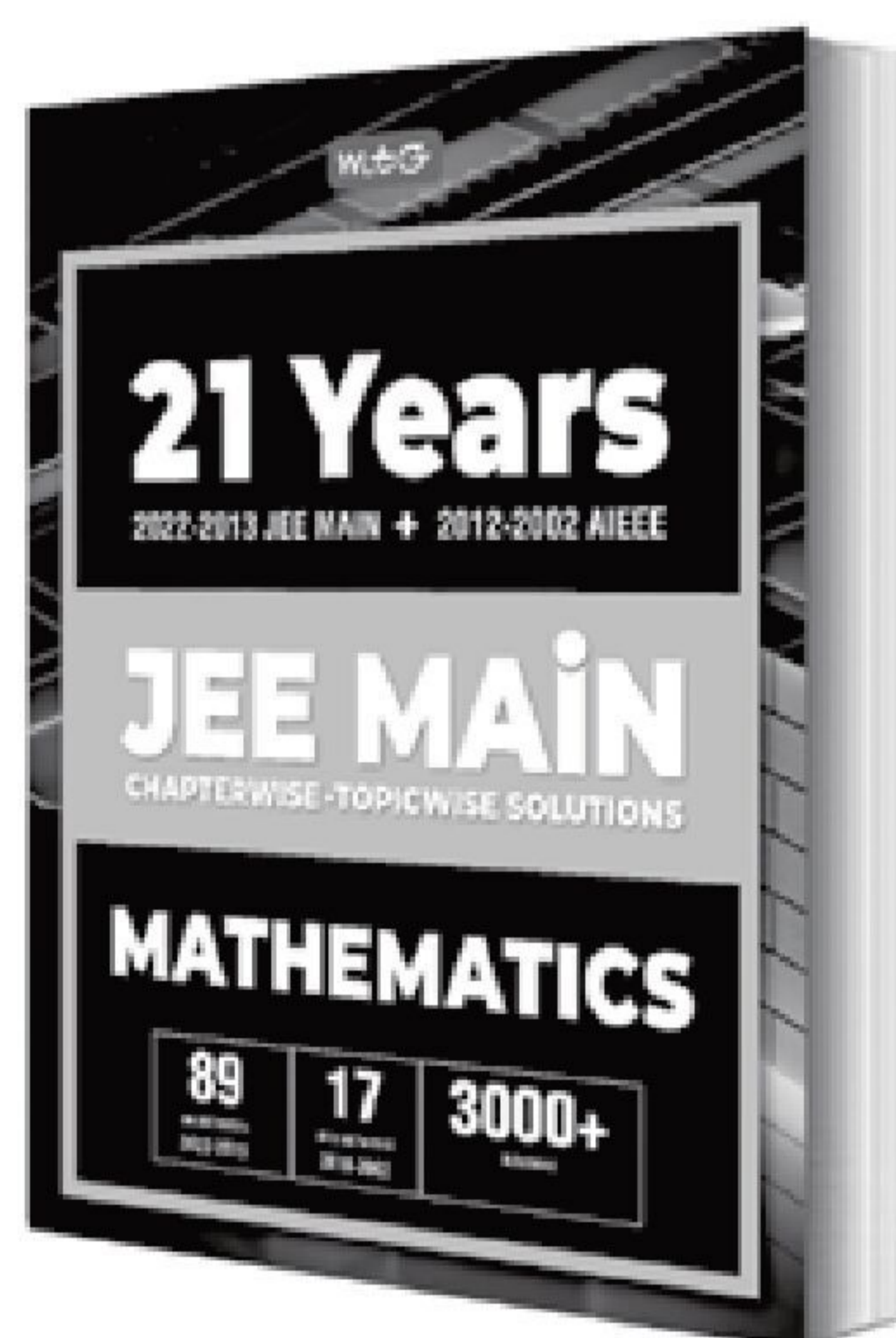
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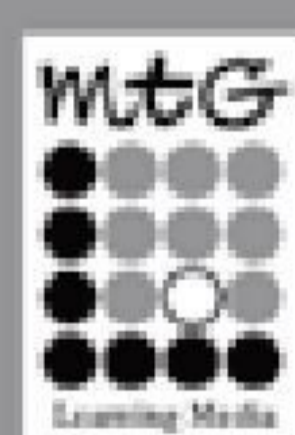


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same was proposed, on the basis of kinetic molecular theory of gases, by Maxwell and Boltzmann as :

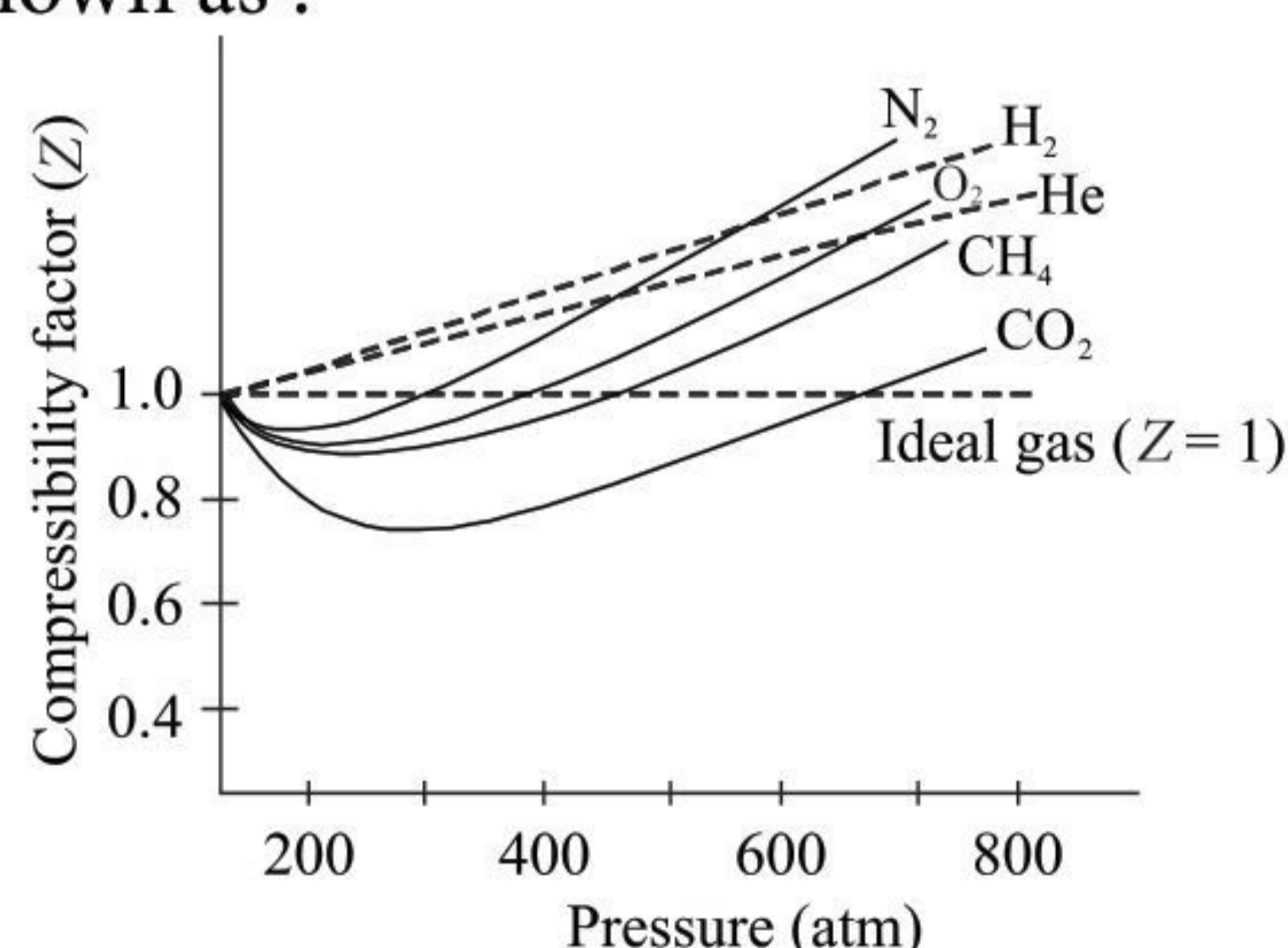
- Gases are made up of a large number of small molecules whose size is negligible as compared to the distance of separation between them.
- Molecules move randomly in different directions with different speeds.
- The intermolecular forces of attraction or repulsion are almost negligible.
- The collisions are called **elastic collisions** because no energy change occurs when two molecules collide *i.e.*, the total kinetic energy remains constant.
- The average kinetic energy of a molecule is proportional to its absolute temperature.
- The pressure exerted by the gas is due to bombardment of its molecules on the walls of the container per unit area.

DEVIATION FROM IDEAL GAS BEHAVIOUR

- Extent of deviation of real gas from ideal behaviour can be conveniently studied in terms of compressibility factor Z which is equal to $\frac{PV}{nRT}$
 - For an ideal gas : $Z = 1$
 - For a real gas : $Z \neq 1$
- For negative deviation $Z < 1$ and for positive deviation $Z > 1$

S.No.	If $Z > 1$	If $Z < 1$
1.	$V_{\text{real}} > V_{\text{ideal}}$	$V_{\text{real}} < V_{\text{ideal}}$
2.	Repulsive forces > attractive forces	Attractive forces > repulsive forces
3.	Gas cannot be compressed easily.	Gas can be compressed easily.
4.	For permanent gases like He, H ₂ .	For gases like CH ₄ , CO ₂ .

- The isotherms for one mole of different gases, plotted against the Z value and pressure, P at 0 °C are shown as :



van der Waals' Equation

$$\left(P_{\text{measured}} + \frac{n^2 a}{V^2} \right)$$



Correction to bring measured P up to the pressure an ideal gas would exert.

$$(V_{\text{measured}} - nb) = nRT$$



Correction to reduce measured V to the volume an ideal gas would have.

- **Special cases of van der Waals' equation :**

At low pressure P ; $PV = RT$ (Ideal gas equation)

At moderate pressure P ; $\frac{PV}{RT}$ *i.e.*, $Z = 1 - \frac{a}{RTV}$

At high pressure P ; $\frac{PV}{RT}$ *i.e.*, $Z = 1 + \frac{Pb}{RT}$

- At high temperature ; $PV = RT$ (Ideal gas equation)
- At low pressure and high temperature, real gas follows ideal gas equation.
- Units of ' a ' = atm L² mol⁻²
- Units of ' b ' = L mol⁻¹

LIQUEFACTION OF GASES

- The phenomenon of converting a gas into liquid at high pressure and low temperature is called liquefaction.
- Whenever the intermolecular forces of attraction in a gas increase to a level that molecules bind together, then liquefaction of gas takes place. Thus, a gas can be liquefied either by cooling or by applying appreciable pressure or by combined effect of both.
- **Critical temperature (T_c)** is the temperature above which a gas cannot be liquefied howsoever high pressure may be applied on the gas. The corresponding pressure and volume are called **critical pressure (P_c)** and **critical volume (V_c)**.
 - Boyle's temperature : $T_b = \frac{a}{Rb}$
 - Critical temperature : $T_c = \frac{8a}{27Rb}$
 - Critical pressure : $P_c = \frac{a}{27b^2}$
 - Critical volume : $V_c = 3b$
 - Relation between critical constants :

$$P_c V_c = \frac{3}{8} RT_c$$

LIQUID STATE

Properties	Description
Surface tension	<p>Force per unit length, acting perpendicular to the tangential line on the surface. It decreases with increase in temperature.</p> $\gamma = \frac{\text{work (}w\text{)}}{\text{change in area (}A\text{)}} = \frac{\text{Force (}F\text{)}}{\text{length (}l\text{)}}$ <p>cgs unit = dynes cm⁻¹ SI unit = N m⁻¹</p>
Viscosity	<p>Internal resistance of flow in liquids which one layer offers to another layer trying to pass over.</p> <p>Coefficient of viscosity, $\eta = \frac{f \cdot dx}{A \cdot dv}$</p> <p>SI unit of viscosity</p> <p>coefficient = N sec m⁻² cgs unit of viscosity coefficient = poise</p>

Vapour pressure

It is the pressure exerted by the vapours on the liquid surface. It increases with rise in temperature.

$$\log \frac{P_2}{P_1} = \frac{\Delta H_{vap}}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

Increases with increase in temperature due to decrease in the magnitude of interparticle forces.

THERMODYNAMICS

THERMODYNAMIC TERMS

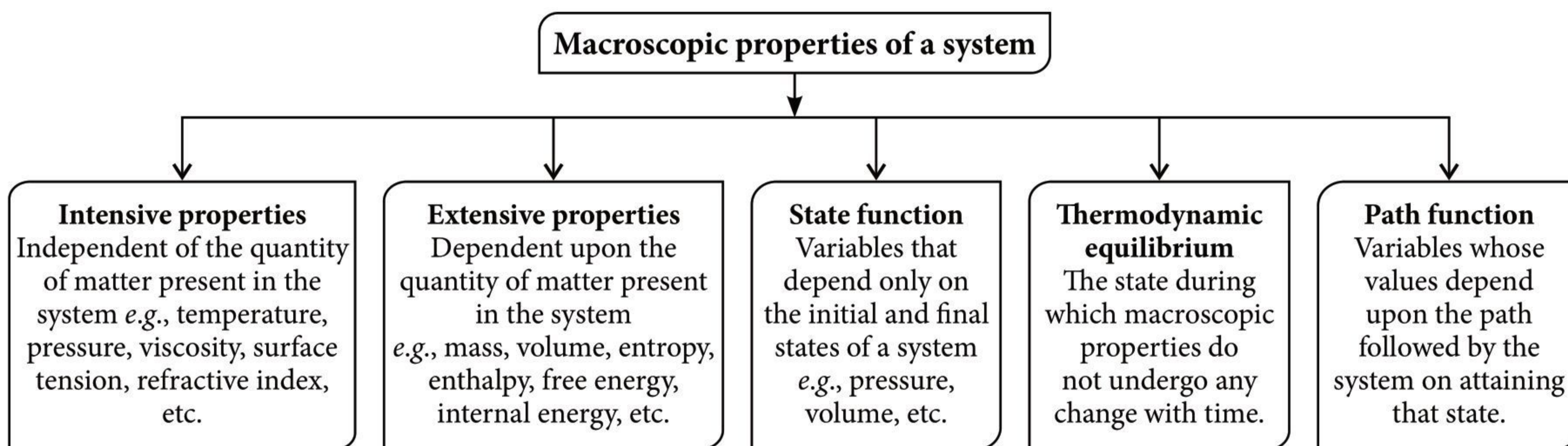
System

A system in thermodynamics refers to that part of universe in which observation are made and remaining universe constitutes the surroundings.

A real or imaginary surface which separates the system from surrounding is called boundary.

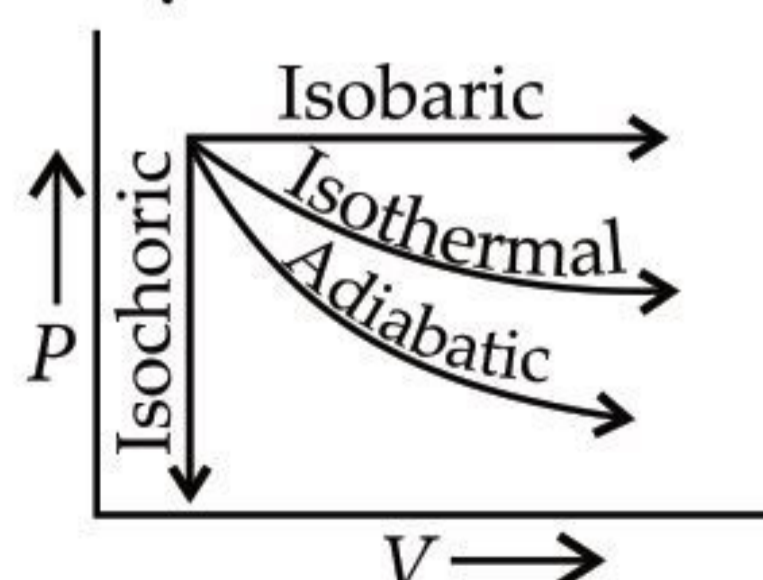
Types of the Systems

A thermodynamic system can be open (exchange of both matter and energy is possible), closed (no exchange of matter but exchange of energy is possible) or isolated (no exchange of matter and energy is possible).



Types of Thermodynamic Processes

- **Isothermal process** : Temperature of the system remains constant ($\Delta T = 0$).
- **Isobaric process** : Pressure of the system remains constant ($\Delta P = 0$).
- **Isochoric process** : Volume of the system remains constant ($\Delta V = 0$).
- **Adiabatic process** : The system does not exchange heat with the surroundings (i.e., $q = 0$).



- **Reversible process** : Direction may be reversed at any stage.
- **Irreversible process** : Proceeds only in one direction and cannot be reversed.
- **Cyclic process** : System returns to its original state after a number of steps. For such a process, $\Delta U = 0$ and $\Delta H = 0$.
- **Exothermic process** : Accompanied by the evolution of heat.
- **Endothermic process** : Accompanied by the absorption of heat.

Internal Energy

- The total energy stored in a substance (or a system) is called its **internal energy**. It is the sum of various energies associated with atoms and molecules such as translational energy (E_t), vibrational energy (E_v), rotational energy (E_r), potential energy (E_p), electronic energy (E_e), nuclear energy (E_n), chemical energy (E_c), etc.

$$\text{Thus, } U \text{ or } E = E_t + E_v + E_r + E_p + E_e + E_n + E_c$$

- It is a state function whose absolute value cannot be determined because all kind of energies associated with it cannot be measured. However, change in internal energy (ΔU) can be calculated.

$$\Delta U = U_2 - U_1 \text{ or } \Delta U = U_{\text{product}} - U_{\text{reactant}}$$

Where, U_2 and U_1 represent the internal energy of final and initial state respectively.

Work (W)

- Work is a mode of energy transfer from or to the system to make some net changes in the state of the system. No work is being done when system is in equilibrium.

- Work = Force \times displacement = $F \times l$

- Electrical work** : It is the work involved in reactions involving ions.

$$\text{Electrical work done} = \text{EMF} \times \text{quantity of electricity.}$$

- Pressure-volume work** : It is the work done involved in expansion or compression of the gases against external pressure.

$$\text{Work} = \text{Force} \times \text{Distance} = \text{Pressure} \times \text{area} \times l \\ = -P_{\text{ext}} \times \Delta V$$

$$\text{where, Force} = \text{Pressure} \times \text{area};$$

$$\text{area} \times l = \text{volume and } \Delta V \text{ is change in volume} \\ \text{i.e., } \Delta V = (V_2 - V_1).$$

Heat (q)

- Heat is a mode of energy transfer between system and surroundings because of difference in temperature between them.
- It is measured in terms of calories. SI unit of heat is joule.

FIRST LAW OF THERMODYNAMICS

- It is a law of conservation of energy which states that energy can neither be created nor destroyed, although it can be converted from one form to another.

$$\text{Mathematically: } \Delta E \text{ or } \Delta U = q + W$$

$$\text{or } q = \Delta U - W$$

- Sign Convention for q and w :**

- If work is done on the system, W is positive.
- If work is done by the system, W is negative.
- If heat is absorbed by the system, q is positive.
- If heat is given out by the system, q is negative.

Enthalpy (H)

- Total heat content of the system at constant pressure is known as its enthalpy.

- Its absolute value cannot be determined.

- Mathematically, it is given as $\Delta H = \Delta U + P\Delta V$

- For exothermic reaction (i.e., heat released during the reaction) ΔH is negative i.e., $\Delta H < 0$. Whereas for endothermic reaction (i.e., heat absorbed during the reaction), ΔH is positive i.e., $\Delta H > 0$.

$$\text{Enthalpy change at constant pressure } (q_p) = \Delta H$$

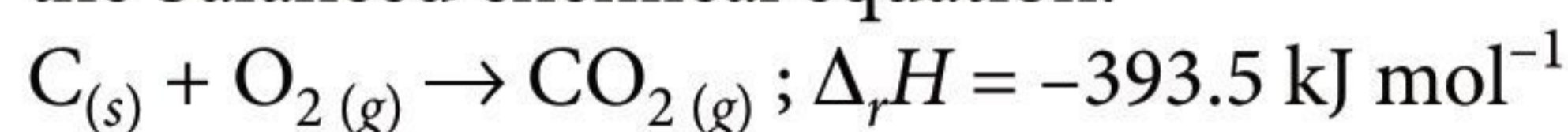
$$\text{Enthalpy change at constant volume } (q_v) = \Delta U$$

$$q_p = q_v + P\Delta V$$

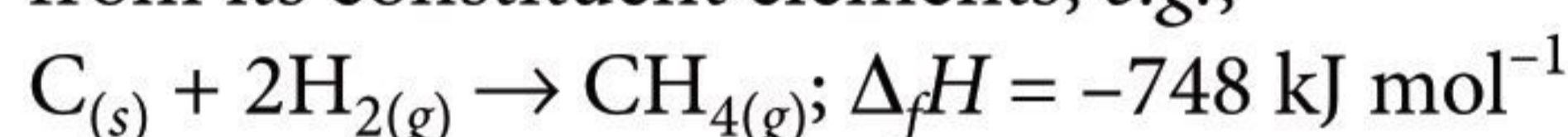
$$\text{or } q_p = q_v + \Delta n_g RT$$

where Δn_g = Difference in the no. of moles of gaseous product and gaseous reactant.

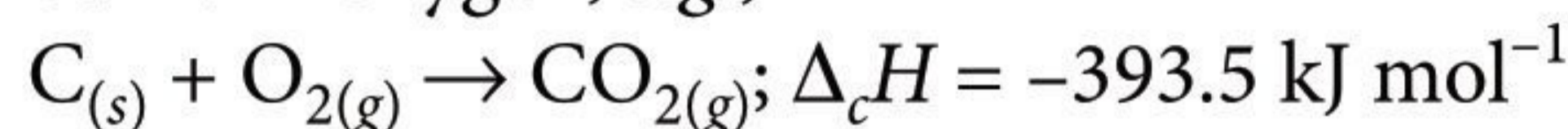
- Enthalpy of reaction** : It is defined as the change in enthalpy, or the amount of heat evolved or absorbed when the number of moles of reactants reacts completely to give the products as given by the balanced chemical equation.



- Enthalpy of formation** : It is the change in enthalpy when one mole of a substance is formed directly from its constituent elements, e.g.,

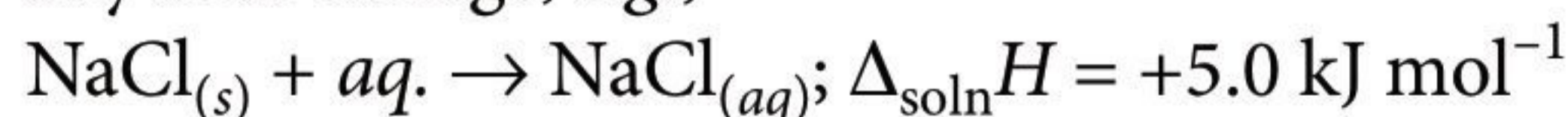


- Enthalpy of combustion** : It is the change in enthalpy when one mole of a substance is completely burnt in oxygen, e.g.,

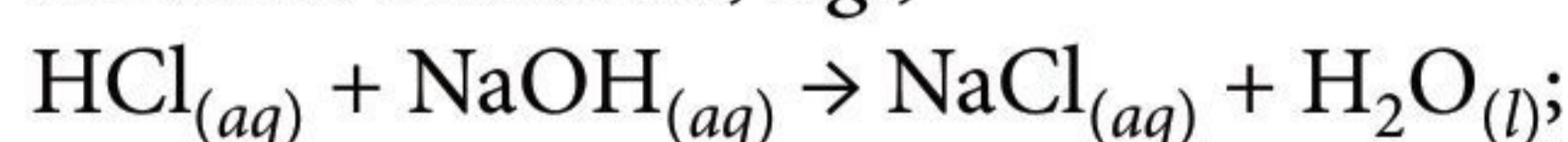


$\Delta_c H$ is always negative as heat is always evolved during combustion.

- Enthalpy of solution** : It is the change in enthalpy when one mole of a substance is dissolved in excess of water so that further dilution does not involve any heat change, e.g.,



- Enthalpy of neutralisation** : It is the change in enthalpy when one gram equivalent of an acid is completely neutralised by 1 g equivalent of a base in dilute solutions, e.g.,



$$\Delta_{\text{neu}} H = -57.1 \text{ kJ mol}^{-1}$$

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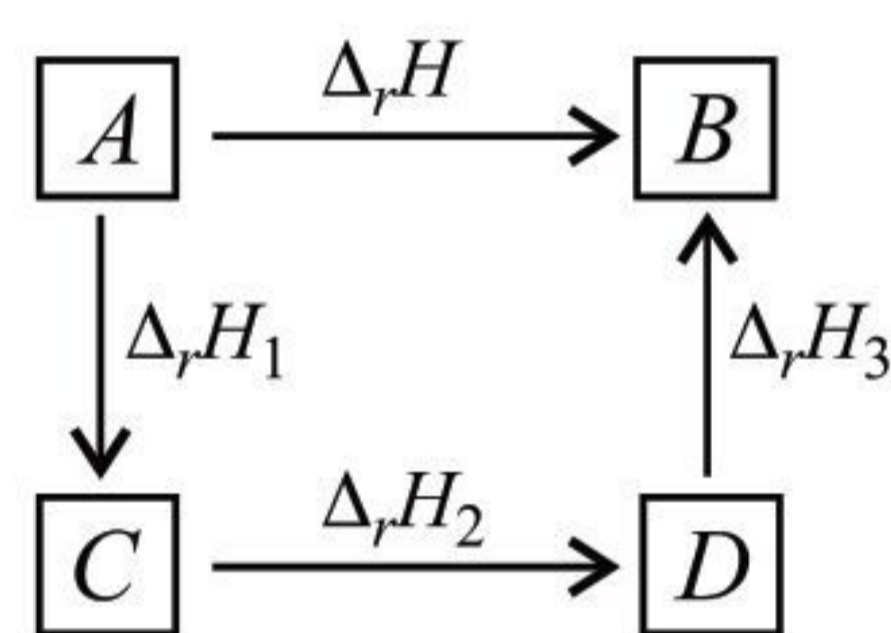


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HIGHLIGHTS:

- 10 Model Test Papers based on latest NEET syllabus
- Last 10 years' solved test papers of AIPMT / NEET
- Includes NEET 2022 solved paper
- OMR Sheet provided after each Model Test Paper
- Detailed solutions for self-assessment and to practice time management

- **Enthalpy of fusion** : It is the change in enthalpy when one mole of a solid is completely converted into liquid state at its melting point, *e.g.*,
 $\text{H}_2\text{O}_{(s)} \rightarrow \text{H}_2\text{O}_{(l)}$ at 0°C ; $\Delta_{\text{fus}}H = +6.0 \text{ kJ mol}^{-1}$
- **Enthalpy of vapourisation** : It is the change in enthalpy when one mole of a liquid is completely converted into its vapours at its boiling point, *e.g.*,
 $\text{H}_2\text{O}_{(l)} \rightarrow \text{H}_2\text{O}_{(g)}$ at 373 K ; $\Delta_{\text{vap}}H = +40.6 \text{ kJ mol}^{-1}$
- **Enthalpy of sublimation** : It is the change in enthalpy when one mole of a solid is directly converted into vapours.
 Also, $\Delta_{\text{sub}}H = \Delta_{\text{fus}}H + \Delta_{\text{vap}}H$
- **Enthalpy of atomization** : It is the change in enthalpy on breaking one mole of bonds completely to obtain atoms in the gas phase,
e.g., $\text{CH}_{4(g)} \rightarrow \text{C}_{(g)} + 4\text{H}_{(g)}$; $\Delta_aH = 1665 \text{ kJ mol}^{-1}$
- **Bond enthalpy** : It is the change in enthalpy associated with breaking and making of chemical bonds, *e.g.*,
 $\text{Cl}_{2(g)} \rightarrow 2\text{Cl}_{(g)}$; $\Delta_{\text{bond}}H = 242 \text{ kJ mol}^{-1}$
- **Hess's Law of constant heat summation**



$$\Delta_r H = \Delta_r H_1 + \Delta_r H_2 + \Delta_r H_3$$

- **Calorimetry** is the quantitative measurement of the heat required or evolved during a chemical process. The principle of measurement is that the heat given out is equal to the heat taken *i.e.*,
 $q = (w + m) \times C \times (T_2 - T_1)$
 where, q = heat of reaction
 w = water equivalent of calorimeter
 m = mass of liquid in calorimeter
 C = specific heat
 T_1 and T_2 = initial and final temperatures of the system respectively.

- **Internal energy change from Bomb calorimeter**

$$\Delta U = \frac{\text{Heat capacity of calorimeter} \times \text{rise in temperature} \times \text{molecular mass of substance}}{\text{Mass of substance taken}}$$

$$= q \times \Delta T \times \frac{M}{m}$$

- **Heat Capacity** : It is the amount of heat required to raise the temperature of the system by 1°C .

$$C = \frac{q}{\Delta T} \text{ . Then,}$$

- C_p/C_v values for different types of gases,

Nature of gas	Monatomic	Diatomic	Triatomic non-linear
$\gamma(C_p/C_v)$	1.66	1.40	1.33

- $C_p - C_v = R$

$$\frac{C_p}{C_v} = \gamma$$

SECOND LAW OF THERMODYNAMICS

- **Entropy (S)** is a measure of the degree of randomness or disorder of the system.
 - ΔS is related with q and T for a reversible reaction as : $\Delta S = \frac{q_{\text{rev}}}{T}$
 - The total entropy change for the system and surroundings of a spontaneous process is given by $\Delta S_{\text{total}} = \Delta S_{\text{system}} + \Delta S_{\text{surrounding}} > 0$
 - Entropy changes during phase transformations are
 $\Delta_{\text{fusion}}S = \frac{\Delta_{\text{fusion}}H}{T_m}$, $\Delta_{\text{vap}}S = \frac{\Delta_{\text{vap}}H}{T_b}$,
 $\Delta_{\text{sub}}S = \frac{\Delta_{\text{sub}}H}{T}$
 where, T_m is the melting point, T_b is the boiling point and T is the temperature at which sublimation occurs.
 - $\Delta_r S^\circ = \sum S^\circ_{\text{products}} - \sum S^\circ_{\text{reactants}}$
- **Entropy change for an ideal gas**

$$\Delta S = C_v \ln \frac{T_2}{T_1} + R \ln \frac{V_2}{V_1} = C_p \ln \frac{T_2}{T_1} + R \ln \frac{P_1}{P_2}$$

$$\Delta S_T = R \ln \frac{V_2}{V_1} = R \ln \frac{P_1}{P_2}$$

$$\Delta S_v = C_v \ln \frac{T_2}{T_1}; \Delta S_p = C_p \ln \frac{T_2}{T_1}$$

- Spontaneous processes are always accompanied by an increase in total entropy of the universe.
- **Gibbs free energy (G)** is the net energy available to do useful work and is a measure of the 'free energy'.
 $G = H - TS$
 - **Standard free energy of a reaction :**
 $\Delta_r G^\circ = \sum \Delta_f G^\circ_{\text{products}} - \sum \Delta_f G^\circ_{\text{reactants}}$

- **Gibbs–Helmholtz equation :**
 $\Delta G = \Delta H - T\Delta S$
- $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$
- $\Delta G^\circ = -nFE^\circ$; where, E° is standard emf of cell.

• **Effect of Temperature on Spontaneity of Reactions**

$\Delta_r H^\circ$	$\Delta_r S^\circ$	$\Delta_r G^\circ$	Description*
–	+	–	spontaneous at all temperatures
–	–	– (at low T)	spontaneous at low temperature
–	–	+ (at high T)	non-spontaneous at high temperature
+	+	+ (at low T)	non-spontaneous at low temperature
+	+	– (at high T)	spontaneous at high temperature
+	–	– (at all T)	non-spontaneous at all temperatures

* The terms low temperature and high temperature are relative. For a particular reaction, high temperature could even mean room temperature.

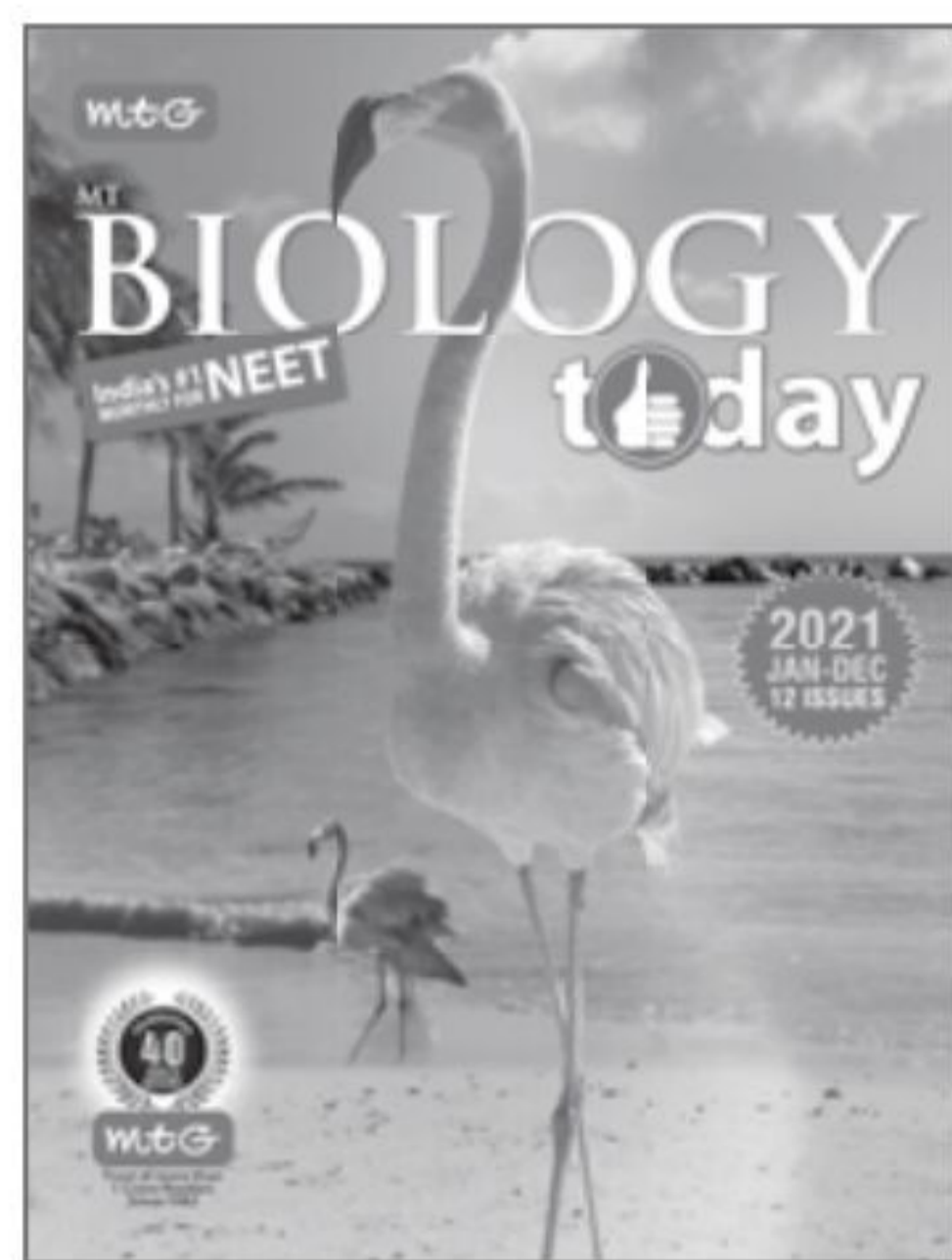
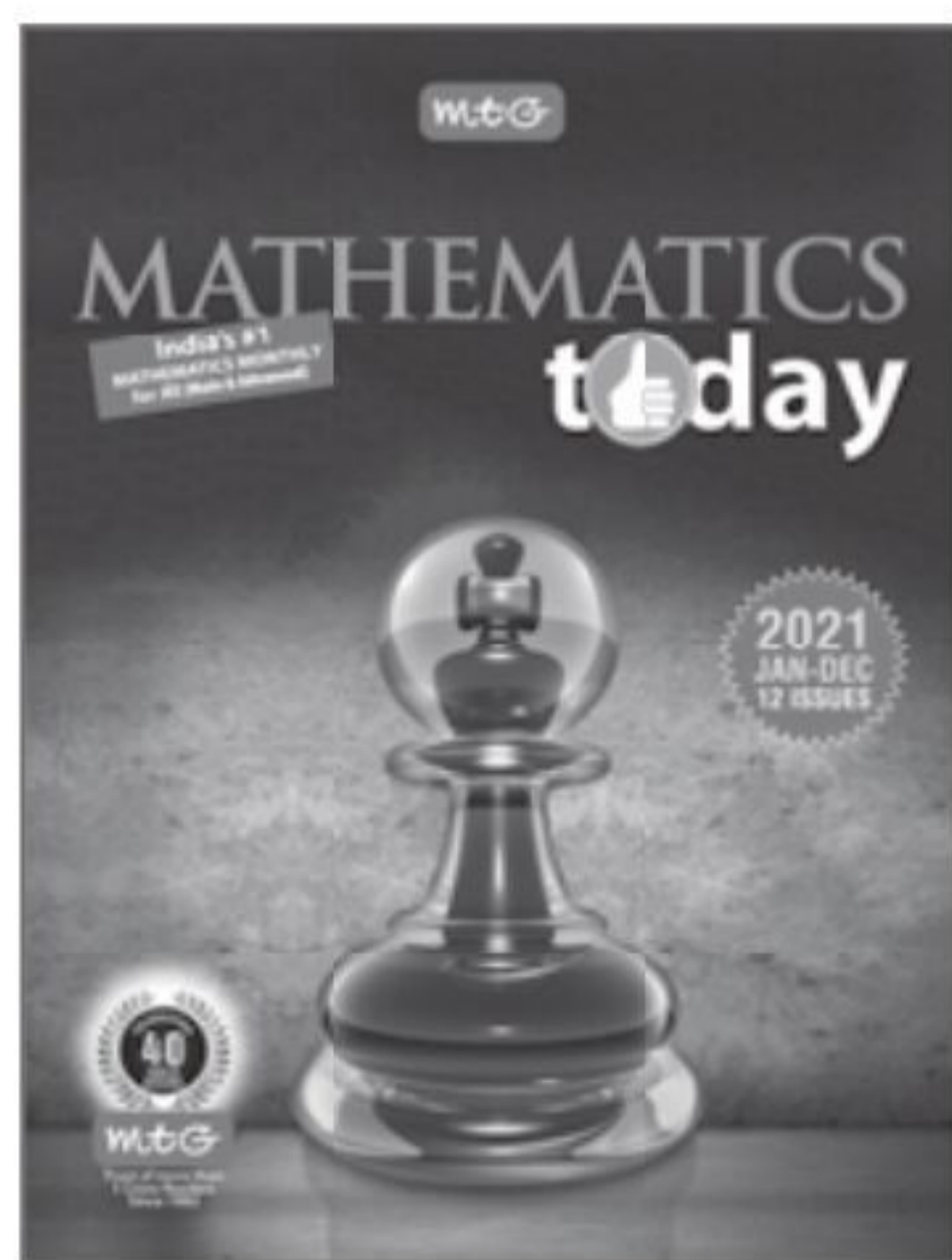
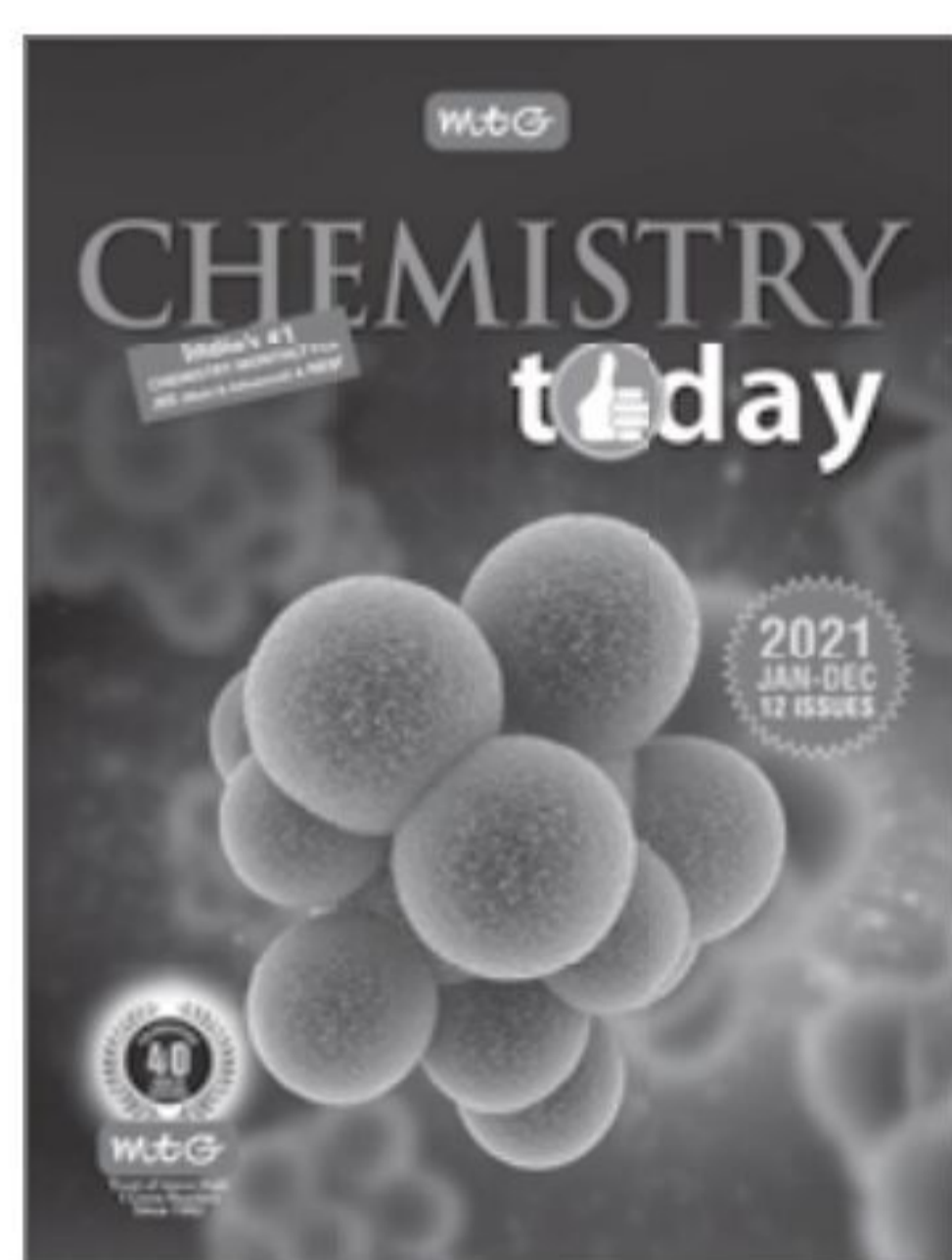
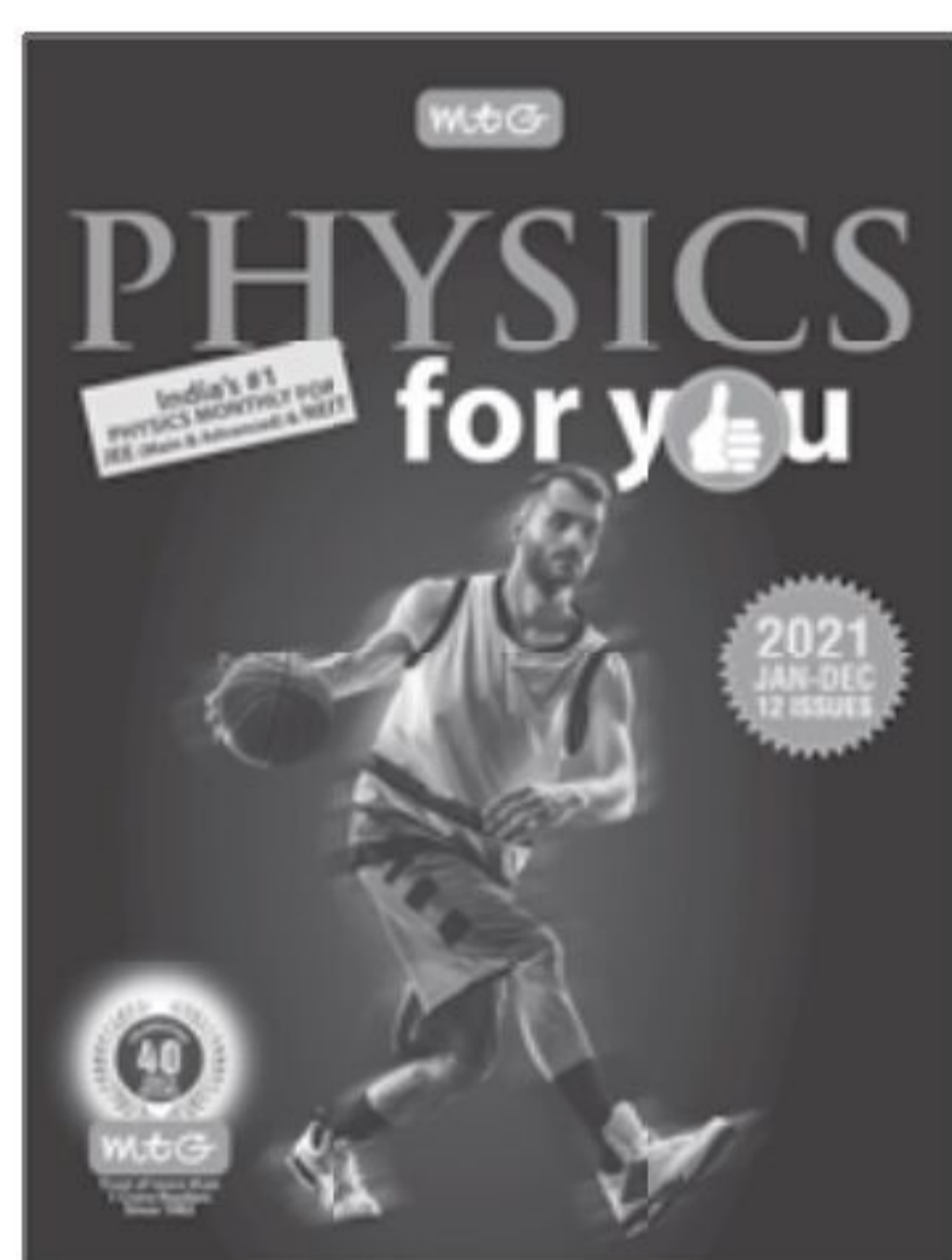
- **Gibbs energy change and equilibrium :** Gibbs energy change, $\Delta_r G^\circ$ is related to the equilibrium constant of the reaction as $\Delta_r G^\circ = -2.303 RT \log K$

ΔG°	$\log K$	K	Comment
$\Delta G^\circ = 0$	$\log K = 0$	1	The equilibrium mixture contains comparable amounts of reactants and products ($K = 1$ for 1 M concentrations and 1 atm partial pressures).
$\Delta G^\circ < 0$	$\log K > 0$	$K > 1$	The equilibrium mixture contains mainly products, exothermic reactions.
$\Delta G^\circ > 0$	$\log K < 0$	$K < 1$	The equilibrium mixture contains mainly reactants, endothermic reactions.

THIRD LAW OF THERMODYNAMICS

- At absolute zero, the entropy of a perfectly crystalline substance is taken as zero.

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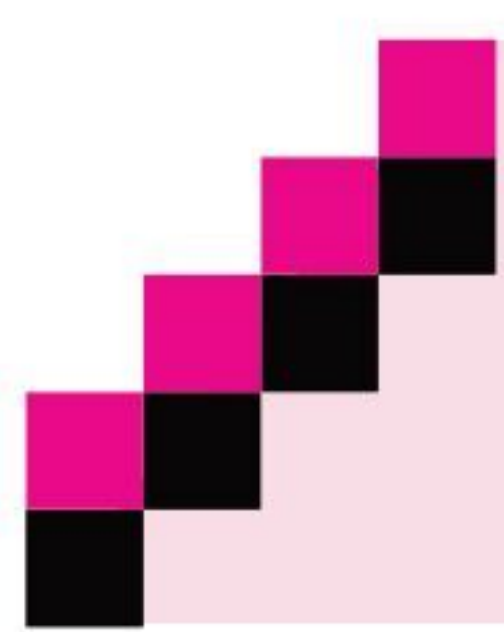
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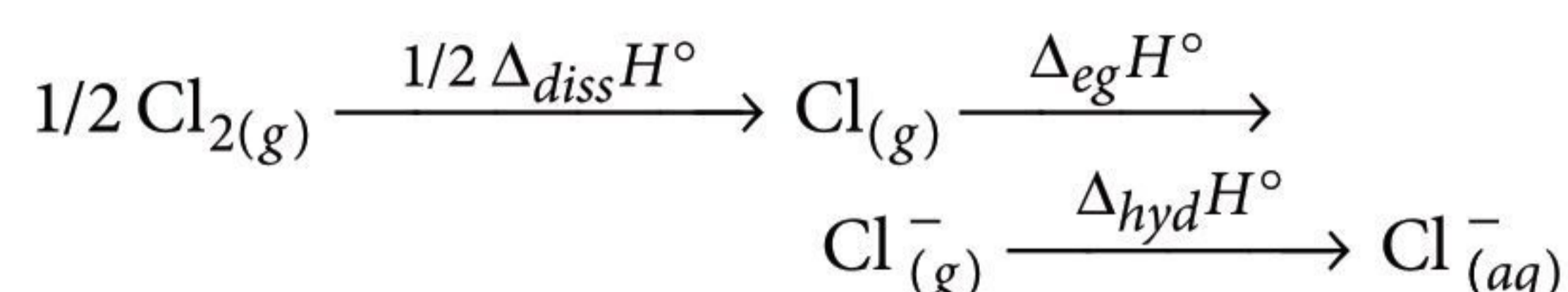
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WRAP it up!

MCQs TYPE QUESTIONS

- Which type of bond is present in Xe molecules?
(a) Covalent (b) Ion-dipole
(c) van der Waals' (d) Dipole-dipole
- Which of the following thermodynamic relation is correct?
(a) $dG = VdP - SdT$ (b) $dE = PdV + TdS$
(c) $dH = -VdP + TdS$ (d) $dG = VdP + SdT$
- Which of the following is true about gaseous state?
(a) Thermal energy = molecular attraction
(b) Thermal energy \gg molecular attraction
(c) Thermal energy \ll molecular attraction
(d) Molecular forces \gg those in liquids
- Identify the correct statement from the following in a chemical reaction.
(a) The entropy always increases.
(b) The change in entropy along with suitable change in enthalpy decides the fate of a reaction.
(c) The enthalpy always decreases.
(d) Both the enthalpy and the entropy remains constant.
- The enthalpy change when 2.63 g of phosphorus reacts with an excess of bromine according to the equation :
 $2P_{(s)} + 3Br_{2(l)} \rightarrow 2PBr_{3(g)}$; $\Delta_r H^\circ = -243 \text{ kJ mol}^{-1}$ will be [Given: Molar mass of phosphorus = 30.97 g mol^{-1}]
(a) 103 kJ (b) 10.3 kJ
(c) 20.6 kJ (d) 24.3 kJ
- 48 litre of dry N_2 is passed through 36 g H_2O at 27°C and this results in a loss of 1.20 g of water. The vapour pressure of water is
(a) 1.03 atm (b) 0.021 atm
(c) 0.034 atm (d) 0.66 atm.
- For the thermochemical equation,
 $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$; $\Delta H = -571.6 \text{ kJ}$
Heat of decomposition of water is
(a) -571.6 kJ (b) $+571.6 \text{ kJ}$
(c) -1143.2 kJ (d) $+285.8 \text{ kJ}$
- Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below:



The energy involved in the conversion of $1/2 Cl_{2(g)}$ to $Cl_{(aq)}^-$ (using data, $\Delta_{diss} H^\circ_{Cl_2} = 240 \text{ kJ mol}^{-1}$, $\Delta_{eg} H^\circ_{Cl} = -349 \text{ kJ mol}^{-1}$,

$\Delta_{hyd} H^\circ_{Cl^-} = -381 \text{ kJ mol}^{-1}$) will be

- $+120 \text{ kJ mol}^{-1}$ (b) $+152 \text{ kJ mol}^{-1}$
 - -610 kJ mol^{-1} (d) -850 kJ mol^{-1}
- A gas cylinder can withstand a pressure of 15 atm. The pressure of cylinder is measured 12 atm at 27°C . Upto which temperature limit the cylinder will not burst?
(a) 375°C (b) 102°C
(c) 33.75°C (d) 240°C
 - The free energy change $\Delta G = 0$ when
(a) the reactants are completely consumed
(b) a catalyst is added
(c) the system is at equilibrium
(d) the reactants are initially mixed.



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11. The equilibrium constant of a reaction is 0.008 at 298 K. The standard free energy change of the reaction at the same temperature is
 (a) +11.93 kJ (b) -11.93 kJ
 (c) -5.43 kJ (d) -8.46 kJ
12. During the melting of solid, which of the following is true?
 (a) $\Delta S = -ve$ (b) $\Delta H = +ve$
 (c) $\Delta S = 0$ (d) $\Delta H = -ve$
13. The correction factor 'a' to the ideal gas equation corresponds to
 (a) density of the gas molecules
 (b) volume of the gas molecules
 (c) electric field present between the gas molecules
 (d) forces of attraction between the gas molecules.
14. Given van der Waals' constant for NH_3 , H_2 , O_2 and CO_2 are respectively 4.17, 0.244, 1.36 and 3.59, which one of the following gases is most easily liquefied?
 (a) NH_3 (b) H_2 (c) O_2 (d) CO_2
15. The heats of combustion of carbon and carbon monoxide are -393.5 and -283.5 kJ mol^{-1} respectively. The heat of formation (in kJ) of carbon monoxide per mole is
 (a) 110 (b) 676.5 (c) -676.5 (d) -110
16. Which of the following is not the postulate of the kinetic theory of gases?
 (a) Gas molecules are in a permanent state of random motion.
 (b) Pressure of gas is due to molecular impacts on the walls.
 (c) The molecules are perfectly elastic.
 (d) The molecular collisions are elastic.
17. Four gases P, Q, R and S have almost same values of 'b' but their 'a' values (a, b are van der Waals constants) are in the order $Q < R < S < P$. At a particular temperature, among the four gases the most easily liquefiable one is
 (a) P (b) Q (c) R (d) S
18. The ratio of Boyle's temperature and critical temperature for a gas is
 (a) $\frac{8}{27}$ (b) $\frac{27}{8}$ (c) $\frac{1}{2}$ (d) $\frac{2}{1}$
19. A liquid can exist only
 (a) between triple point and critical temperature
 (b) at any temperature above the melting point
 (c) between melting point and critical temperature
 (d) between boiling and melting temperature.
20. With rise in temperature, viscosity of a liquid
 (a) increases
 (b) decreases
 (c) remains constant
 (d) may increase or decrease.

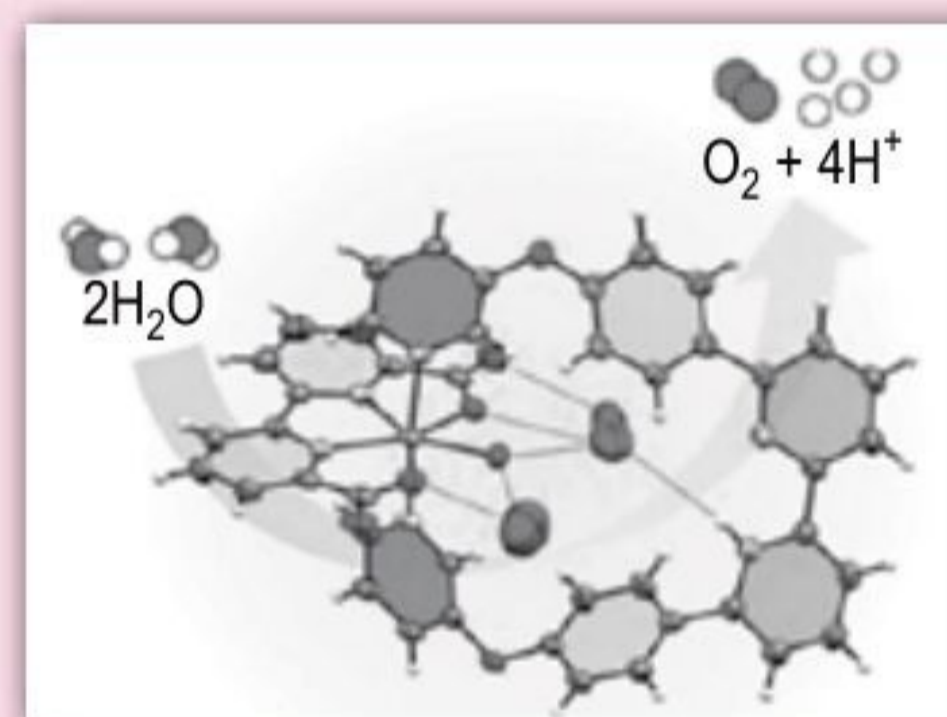
NUMERICAL VALUE TYPE QUESTIONS

21. The magnitude of heat of formation of KOH is _____.
 (Given:
 $\text{K} + \text{H}_2\text{O} + aq \rightarrow \text{KOH}_{(aq)} + 1/2\text{H}_2$; $\Delta H = -48.4 \text{ kcal}$
 $\text{H}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O}$; $\Delta H = -68.44 \text{ kcal}$
 $\text{KOH} + aq \rightarrow \text{KOH}_{(aq)}$; $\Delta H = -14.01 \text{ kcal}$)
22. One mole of a non-ideal gas undergoes a change of state (2.0 atm, 3.0 L, 95 K) to (4.0 atm, 5.0 L, 245 K) with a change in internal energy, $\Delta U = 30.0 \text{ L}$

CHEMISTRY BULLETIN

A synthetic enzyme that divides water molecules into oxygen and hydrogen has been discovered by German researchers.

A team from the University of Würzburg successfully discovered a method for making an artificial "pocket" that could divide molecules.



This research presents a new enzyme-like molecular catalyst for water oxidation.

The long-term aim of the research of Würzburg group is to integrate the water oxidation catalyst into an artificial device that splits water into oxygen and hydrogen with the aid of sunlight. It will take some time, as the catalyst must be coupled with other components to form a functioning system as a whole – with light-harvesting dyes and with so-called reduction catalysts.

The researchers group presents the details of their novel concept in the journal 'Nature Catalysis'. The team consisting of Niklas Noll, Ana-Maria Krause, Florian Beuerle and Frank Würthner is convinced that this principle is also suitable for improving other catalytic processes.

Water splitting is not trivial

Water consists of one oxygen and two hydrogen atoms. To release the hydrogen, the oxygen must be removed from two water molecules. To do so, it is necessary to remove four electrons and four protons from the two water molecules first.

atm. The change in enthalpy (ΔH) of the process (in L atm) is _____.

23. A rigid nitrogen tank stored inside a laboratory has a pressure of 30 atm at 06:00 am when the temperature is 27°C . At 03:00 pm, when the temperature is 45°C , the pressure in the tank will be _____ atm. (Nearest integer)
24. Geraniol, a volatile organic compound, is a component of rose oil. The density of the vapour is 0.46 g L^{-1} at 257°C and 100 mm Hg. The molar mass of geraniol is _____ g mol^{-1} . (Nearest integer) [Given : $R = 0.082\text{ L atm K}^{-1}\text{ mol}^{-1}$]
25. NaClO_3 is used, even in space crafts, to produce O_2 . The daily consumption of pure O_2 by a person is 492 L at 1 atm, 300 K. The amount of NaClO_3 , (in grams) required to produce O_2 for the daily consumption of a person at 1 atm, 300 K is _____.
 $\text{NaClO}_{3(s)} + \text{Fe}_{(s)} \rightarrow \text{O}_{2(g)} + \text{NaCl}_{(s)} + \text{FeO}_{(s)}$
 $(R = 0.082\text{ L atm mol}^{-1}\text{ K}^{-1})$

SOLUTIONS

1. (c) : In Xe-molecule, the type of bonding which exists is van der Waals' forces.
2. (a)
3. (b) : For gaseous state, thermal energy \gg molecular attraction.
4. (b) : $\Delta G = \Delta H - T\Delta S$
 For a reaction to be spontaneous, ΔG should be negative. Thus, ΔS and ΔH decides the fate of a reaction.
5. (c) 6. (c)
7. (d) 8. (c)
9. (b) : Cylinder will burst at that temperature when it attains the pressure of 15 atm.
 $P_1 = 12\text{ atm}; T_1 = 27^\circ\text{C} = 27 + 273 = 300\text{ K};$
 $P_2 = 15\text{ atm}; T_2 = ?$
 $\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow T_2 = \frac{15 \times 300}{12} = 375\text{ K}$
 $= (375 - 273)^\circ\text{C} = 102^\circ\text{C}$
10. (c)
11. (a) : $\Delta G^\circ = -2.303 RT \log K$
 $\Delta G^\circ = -2.303 \times 8.314 \times 298 \log (0.008)$
 $\Delta G^\circ = -5705.84 \times (-2.09)$
 $\Delta G^\circ = 11925.2\text{ J or } +11.93\text{ kJ}$
12. (b) : Heat is absorbed.
13. (d)
14. (a) : van der Waals' constant 'a' signifies the intermolecular forces of attraction between the particles of gas. So, higher the value of 'a', easier will be the liquefaction of gas.
15. (d) 16. (c) 17. (a)
18. (b) : Boyle's temperature, $T_b = \frac{a}{Rb}$
 Critical temperature, $T_c = \frac{8a}{27Rb}$
 $\therefore \frac{T_b}{T_c} = \frac{27}{8}$
19. (d)
20. (b) : Viscosity decreases with increase in temperature.
21. (103)
22. (44) : $H = U + PV,$
 $H_1 = U_1 + (2 \times 3) = U_1 + 6$
 $H_2 = U_2 + (4 \times 5) = U_2 + 20$
 $(H_2 - H_1) = (U_2 - U_1) + (20 - 6)$
 $\Delta H = \Delta U + 14, \Delta H = 30 + 14 \Rightarrow \Delta H = 44\text{ L-atm}$
23. (32)
24. (152) : Given, density of gas = $0.46\text{ g L}^{-1},$
 $T = 257^\circ\text{C} = 257 + 273 = 530\text{ K}$
 Pressure of gas = $100\text{ mm Hg} = \frac{100}{760}\text{ atm}$
 We know, $PV = nRT$
 $P = \frac{d \times RT}{M} \Rightarrow M = \frac{d \times R \times T}{P}$
 $= \frac{0.46 \times 0.082 \times 530}{100/760} = 151.9 \approx 152\text{ g/mol}$
25. (2130)



TRIO

ANSWERS OCTOBER 2022

The three letter word is **ENZ**.

BENZOQUINONE
 ETHYLBENZENE
 BENZONITRILE
 VINYLBENZENE
 ENZYMES

Winner : Gagan Marer

WORD GRID

Readers are requested to send their responses of word grid. Be the Winner!

Find and encircle the words in the given grid, running in one of the possible directions; horizontal, vertical or diagonal by reading the clues given below.



A	C	E	T	I	C	A	N	H	Y	D	R	I	D	E	T
C	Y	N	M	K	Y	C	W	G	O	I	E	A	O	P	R
Y	A	D	N	A	W	D	X	F	L	L	D	N	A	Q	A
W	N	A	P	L	X	F	Y	E	K	U	Y	M	B	S	N
S	I	C	Q	A	X	G	Z	D	A	T	X	D	C	W	Q
T	D	D	O	C	M	H	B	C	R	I	W	L	E	Z	U
U	E	E	R	T	N	J	L	M	M	O	Y	K	F	R	I
D	R	Z	S	O	O	K	O	N	A	N	Z	G	H	M	L
E	W	Y	T	S	M	P	Q	R	S	T	U	J	I	N	I
N	X	E	L	E	C	T	R	O	P	H	I	L	E	R	Z
T	B	N	F	X	U	U	C	C	D	B	A	X	W	T	E
Y	C	L	T	Y	R	U	I	N	D	I	C	A	T	O	R
W	D	A	U	Z	I	V	W	Y	B	N	M	L	J	H	F
X	E	R	W	T	E	X	Z	A	O	C	D	E	K	I	G

Clues

1. It is a unit of activity and represents the rate of disintegration, named after a famous scientist.
2. The ion containing C — N bond, which prevents the cells of the body from using oxygen.
3. An electron deficient species, that acts as Lewis acid.
4. Process of decreasing concentration of solute by addition of solvent.
5. Coloured substance, usually derived from plant material that can exist in either acid or base form or have different colour in acid or base medium.
6. A disaccharide consisting of β -D-galactose and β -D-glucose units. The linkage is between C-1 of galactose and C-4 of glucose.
7. A neurologically active drug that affects the message transfer mechanism from nerve to receptor.
8. A chemical compound having formula $(\text{CH}_3\text{CO}_2)\text{O}$.

*Please send entries of solutions both with words and scanned copy of the grid by 10th of every month.

CONCEPT MAP

ORGANIC CHEMISTRY - SOME BASIC PRINCIPLES AND TECHNIQUES

TETRAVALENCE OF CARBON-SHAPES OF ORGANIC COMPOUNDS

The knowledge of fundamental concepts of molecular structure helps in understanding and predicting the properties of organic compounds. Shapes of molecules like methane, ethene and ethyne are explained in terms of the use of sp^3 , sp^2 and sp hybrid orbitals by carbon atoms in the respective molecules.

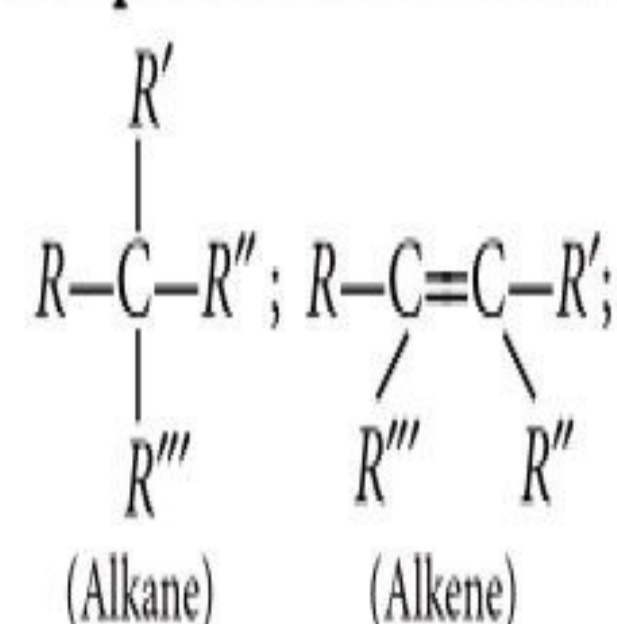
sp^3 -Tetrahedral (109.5°) sp^2 -Trigonal planar (120°)
 sp -Linear (180°)

IUPAC Nomenclature

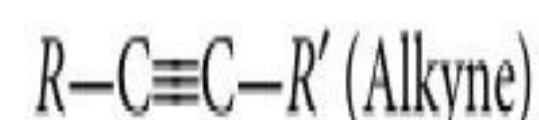
- Word root**
Indicates the number of carbon atoms attached in the longest chain.
- Primary prefix**
Indicates the presence of alicyclic system
- Secondary prefix**
Indicates the nature of side chains and substituents attached to longest chain selected.
- Primary suffix**
Indicates the nature of C-C bond in the longest chain selected.
- Secondary suffix**
Indicates the nature of functional group.

Structural Representation of Organic Compounds

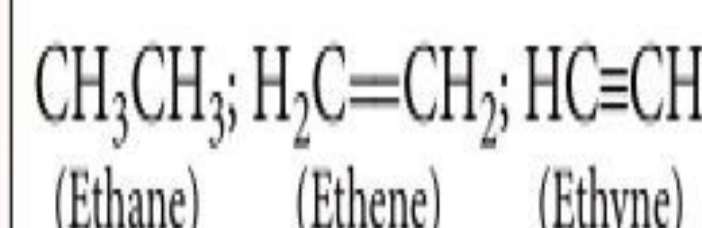
Complete structural formula



(Alkane) (Alkene)



Condensed structural formula



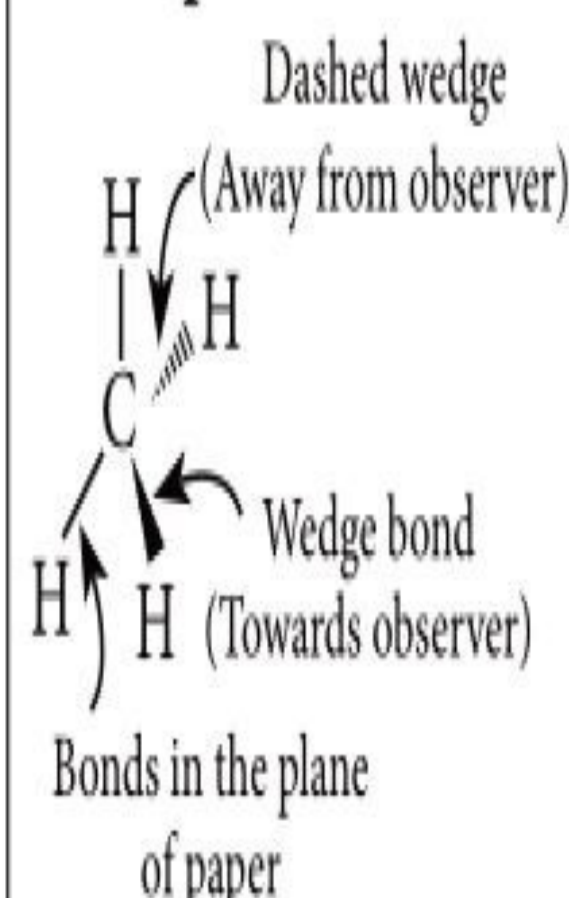
(Ethane) (Ethene) (Ethyne)

Bond line structural formula



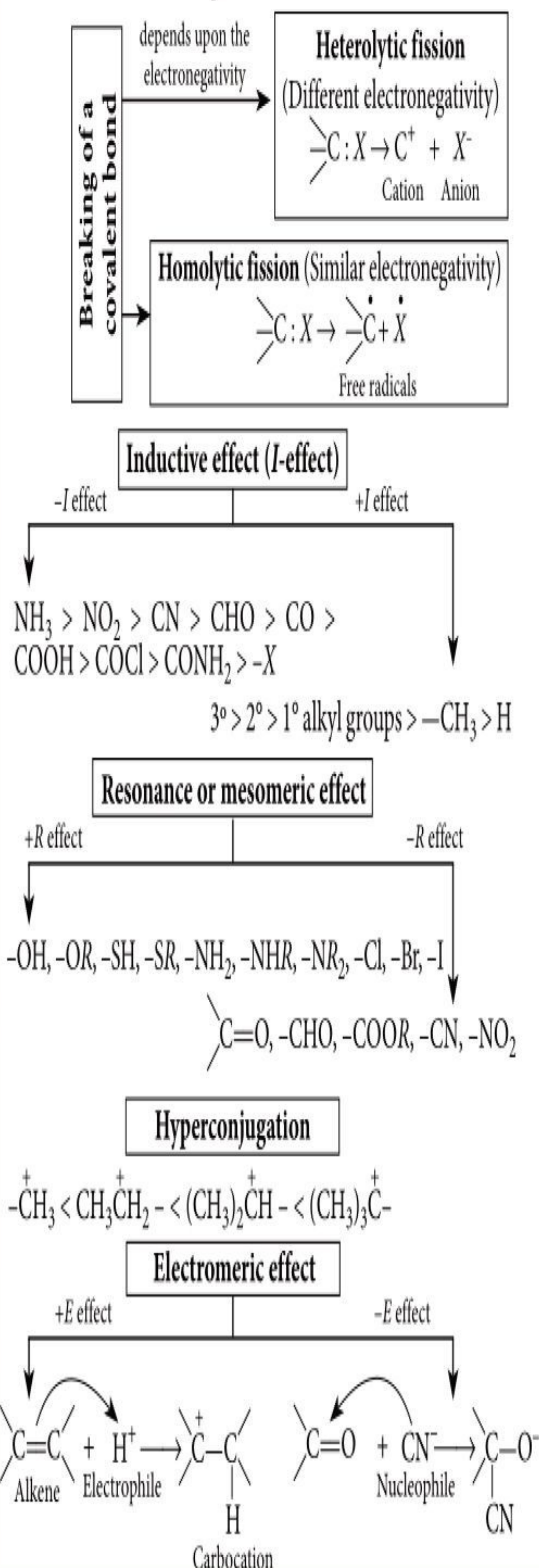
(n-Heptane)

Three dimensional representation



Bonds in the plane of paper

Electronic Displacement in Covalent Bonds

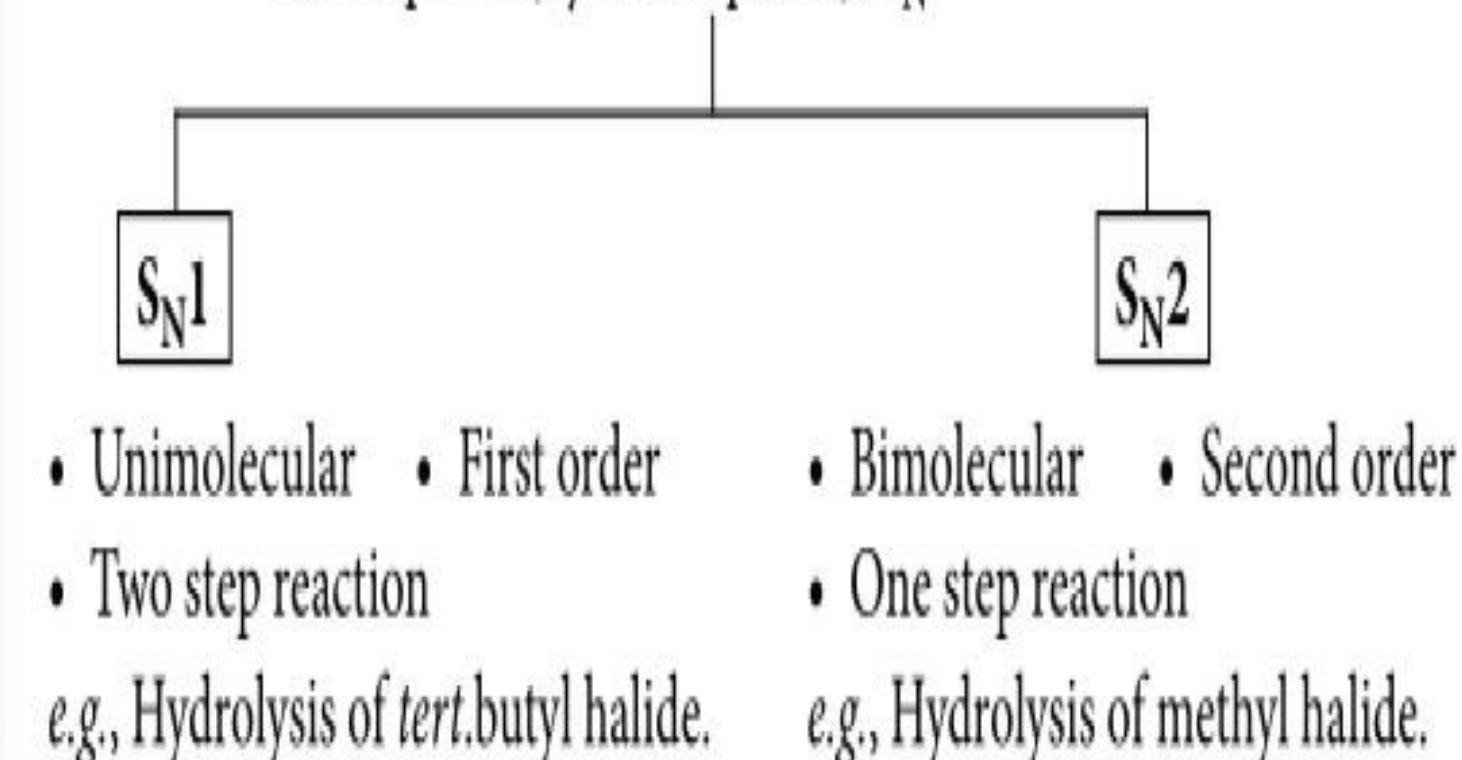


Types of Organic Reactions

Substitution Reaction (Replacement of an atom by a different atom)

Reaction is done by-

- Free radicals (e.g., Wurtz reaction)
- Ions
 - Electrophilic (by electrophiles), S_E
 - Nucleophilic (by nucleophiles), S_N



Addition Reaction (Compounds containing double (=) or triple (\equiv) bonds)

Reaction is done by-

- Free radical (e.g., Peroxide effect)
- Ion
 - Nucleophilic, A_N
 - Electrophilic, A_E (e.g., Markownikoff's rule)

Elimination Reaction (Reverse of addition reaction)

- α -elimination: Two atoms or groups are lost from the same carbon atom to form carbene.
- β -elimination: Two atoms or groups are lost from adjacent carbon atoms to form an unsaturated compound.

Rearrangement Reaction (Migration of an atom/group within the molecule.)

ISOMERISM

Stereoisomerism

Configurational

Geometrical

Involves double bond that does not allow free rotation

Cis-trans isomers

Enantiomers

- Compounds that rotate plane polarised light are optically active

Dextrorotatory (*d*) rotates plane polarised light towards right

Conformational

(Differ in conformational Stability : Staggered > Gauche > Eclipsed)

Optical

Involves an atom usually with carbon connected to four different groups/atoms.

Diastereomers

Laevorotatory (*l*) rotates plane polarised light towards left

METHODS OF PURIFICATION OF ORGANIC COMPOUNDS

Quantitative Analysis of Organic Compounds

Element	Method
Carbon and Hydrogen	Liebig's Combustion method
Nitrogen	Dumas method and Kjeldahl's method
Halogens	Carius method
Sulphur	Carius method
Phosphorus	Ignition method
Oxygen	Iodine method

Qualitative Analysis of Organic Compounds

Element	Detection	Confirmatory test
Carbon	$2\text{CuO} + \text{C} \xrightarrow{\Delta} 2\text{Cu} + \text{CO}_2 \uparrow$	CO_2 gas turns lime water milky.
Hydrogen	$\text{CuO} + 2\text{H} \xrightarrow{\Delta} \text{Cu} + \text{H}_2\text{O}$	Water droplets appear on the cooler part of the ignition tube and also turns anhydrous CuSO_4 blue.
Nitrogen	$\text{Na} + \text{C} + \text{N} \xrightarrow{\Delta} \text{NaCN (L.E.)}$ (L.E. = Lassaigne Extract)	L.E. + $\text{FeSO}_4 + \text{NaOH}$, boil and cool + $\text{FeCl}_3 + \text{conc. HCl}$ — gives blue or green colour.
Sulphur	$2\text{Na} + \text{S} \xrightarrow{\Delta} \text{Na}_2\text{S (L.E.)}$	L.E. + sodium nitroprusside gives deep violet colour.
Halogens	$\text{Na} + \text{X} \xrightarrow{\Delta} \text{NaX (L.E.)}$	L.E. + $\text{HNO}_3 + \text{AgNO}_3$ - White ppt. soluble in aq. NH_3 confirms Cl.
Nitrogen and sulphur together	$\text{Na} + \text{C} + \text{N} + \text{S} \xrightarrow{\Delta} \text{NaSCN}$ Sodium thiocyanate (L.E.)	Blood red colouration confirms presence of both N and S.
Phosphorus	$\text{P} \xrightarrow[\Delta]{\text{Na}_2\text{O}_2, \text{boil}} \text{Na}_3\text{PO}_4$	Solution is boiled with nitric acid and then treated with $(\text{NH}_4)_2\text{MoO}_4$. Formation of yellow ppt. indicates presence of phosphate.

Structural isomerism

Chain isomerism

Difference in arrangement of carbon chain. e.g., *n*-butane and isobutane

Position isomerism

Difference in position of functional group e.g., But-1-ene and But-2-ene

Ring-chain isomerism

Difference in mode of linkage of carbon atoms (open chain or cyclic structure) e.g. prop-1-ene and cyclopropane

Functional isomerism

Difference in nature of functional group e.g. Ethanol and dimethylether

Metamerism

Difference in nature of alkyl group attached on either side of functional group e.g. methyl-*n*-propyl ether and diethylether

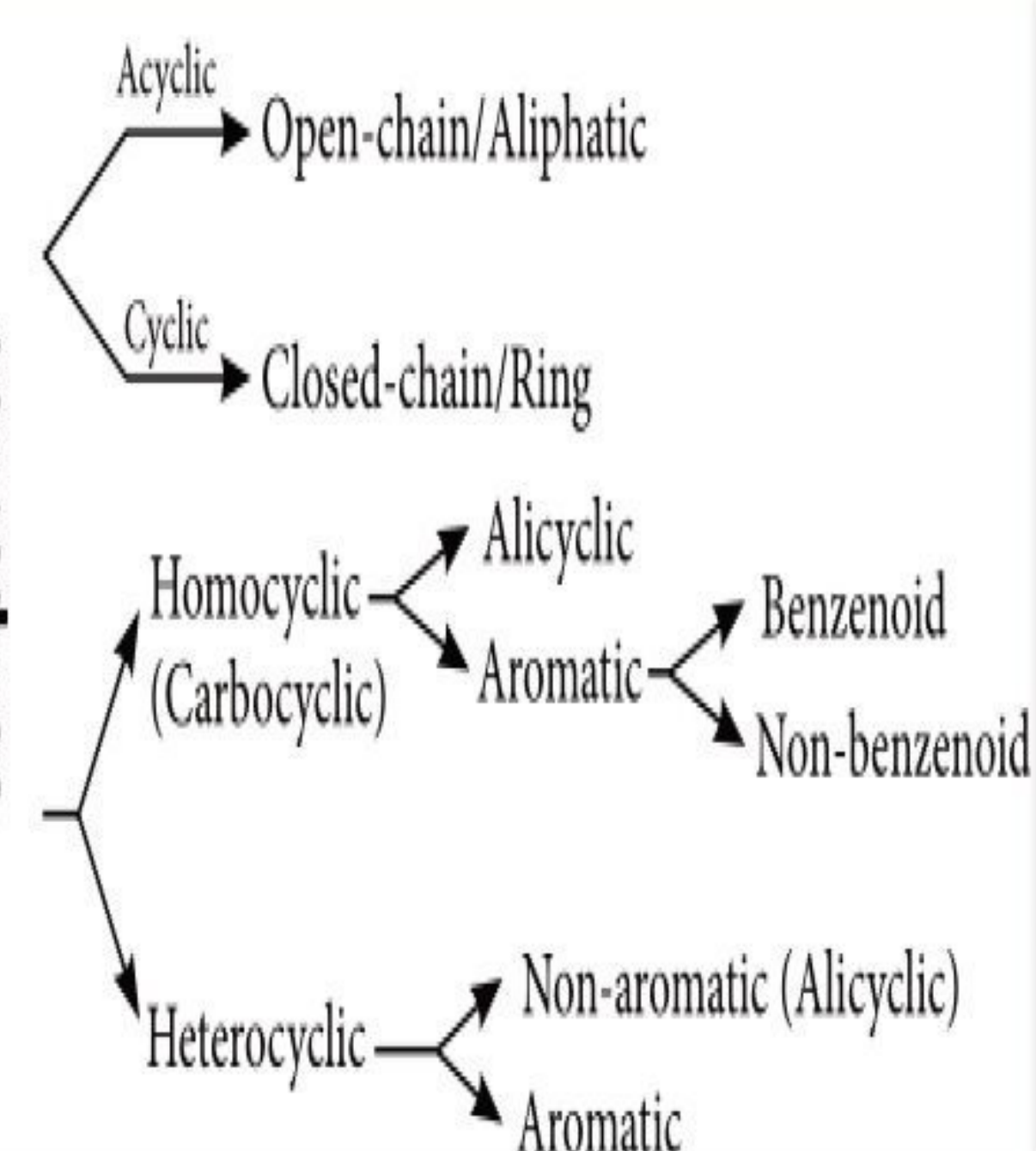
Tautomerism

Isomers existing in dynamic equilibrium e.g. keto-enol tautomers or nitrite-nitro tautomers.

Methods of purification of organic compounds

Various methods can be used for purification such as crystallisation, sublimation, distillation (fractional distillation, distillation under reduced pressure, steam distillation), differential extraction, chromatography, adsorption chromatography (column and thin layer chromatography), partition chromatography (paper chromatography).

Classification of Organic Compounds





CBSE

warm-up!

CLASS-XI

Chapterwise practice questions for CBSE Exams as per the latest pattern and reduced syllabus by CBSE for the academic session 2022-23.

Series-4

Equilibrium

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

Read the following instructions carefully.

- There are 35 questions in this question paper with internal choice.
- SECTION A consists of 18 multiple-choice questions carrying 1 mark each.
- SECTION B consists of 7 very short answer questions carrying 2 marks each.
- SECTION C consists of 5 short answer questions carrying 3 marks each.
- SECTION D consists of 2 case-based questions carrying 4 marks each.
- SECTION E consists of 3 long answer questions carrying 5 marks each.
- All questions are compulsory.
- Use of log tables and calculators is not allowed.

SECTION A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

- Which of the following is a conjugate acid of SO_4^{2-} ?
 (a) HSO_4^- (b) H^+
 (c) H_2SO_4 (d) SO_4^{2-}
- For the following reaction :
 $\text{NO}_{(g)} + \text{O}_{3(g)} \rightleftharpoons \text{NO}_{2(g)} + \text{O}_{2(g)}$
 The value of K_c is 8.2×10^4 . What will be the value of K_c for the reverse reaction?
 (a) 8.2×10^4 (b) $\frac{1}{8.2 \times 10^4}$
 (c) $(8.2 \times 10^4)^2$ (d) $\sqrt{8.2 \times 10^4}$
- For the reaction $\text{N}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{NO}_{(g)}$, the value of K_c at 800°C is 0.1. What is the value of K_p at this temperature?
 (a) 0.5 (b) 0.01 (c) 0.05 (d) 0.1

- Classify the following as acid or base according to Bronsted-Lowry concept.

- (i) CH_3COO^- (ii) H_3O^+
 (iii) SO_4^{2-} (iv) HCl

- | | (i) | (ii) | (iii) | (iv) |
|-----|---------------|---------------|---------------|---------------|
| (a) | Bronsted base | Bronsted base | Bronsted base | Bronsted acid |
| (b) | Bronsted acid | Bronsted acid | Bronsted acid | Bronsted base |
| (c) | Bronsted base | Bronsted acid | Bronsted base | Bronsted acid |
| (d) | Bronsted acid | Bronsted acid | Bronsted base | Bronsted base |

- For the reaction $2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$ at 300 K , the value of ΔG° is $-690.9 R$. The equilibrium constant value for the reaction at that temperature is
 (R is gas constant)

- (a) 10 atm^{-1} (b) 10 atm
(c) 10 (d) 1
6. Calculate K_c for the reversible process given below if $K_p = 167$ and $T = 800^\circ\text{C}$.
 $\text{CaCO}_{3(s)} \rightleftharpoons \text{CaO}_{(s)} + \text{CO}_{2(g)}$
 (a) 1.95 (b) 1.85 (c) 1.89 (d) 1.60
7. For a reaction $\text{C}_{(s)} + \text{CO}_{2(g)} \rightleftharpoons 2\text{CO}_{(g)}$, the partial pressures of CO_2 and CO are 4 and 8 atm respectively, K_p for the reaction is
 (a) 0.5 (b) 2 (c) 16 (d) 4
8. A vessel of one litre capacity containing 1 mole of SO_3 is heated till a state of equilibrium is attained.
 $2\text{SO}_{3(g)} \rightleftharpoons 2\text{SO}_{2(g)} + \text{O}_{2(g)}$
 At equilibrium, 0.6 moles of SO_2 had formed. The value of equilibrium constant is
 (a) 0.18 (b) 0.36 (c) 0.45 (d) 0.68
9. Formation of ClF_3 from Cl_2 and F_2 is an exothermic process. The equilibrium system can be represented as
 $\text{Cl}_{2(g)} + 3\text{F}_{2(g)} \rightleftharpoons 2\text{ClF}_3; \Delta H = -329 \text{ kJ mol}^{-1}$
 Which of the following will increase quantity of ClF_3 in the equilibrium mixture?
 (a) Increase in temperature, decrease in pressure, addition of Cl_2
 (b) Decrease in temperature and pressure, addition of ClF_3
 (c) Increase in temperature and pressure, removal of Cl_2
 (d) Decrease in temperature, increase in pressure, addition of F_2
10. K_p/K_c for the reaction, $\text{A}_{(g)} + 2\text{B}_{(g)} \rightleftharpoons \text{AB}_{2(g)}$ is
 (a) RT (b) $(RT)^2$
 (c) $1/RT$ (d) $1/(RT)^2$
11. The first and second dissociation constants of an acid H_2A are 1.0×10^{-5} and 5.0×10^{-10} respectively. The overall dissociation constant of the acid will be
 (a) 0.2×10^5 (b) 5.0×10^{-5}
 (c) 5.0×10^{15} (d) 5.0×10^{-15}
12. The solubility of $\text{Fe}(\text{OH})_3$ is $x \text{ mol L}^{-1}$. Its K_{sp} would be
 (a) $9x^3$ (b) $3x^4$
 (c) $27x^4$ (d) $9x^4$
13. The solubility product of $\text{Mg}(\text{OH})_2$ is $4 \times 10^{-12} (\text{mol lit}^{-1})^3$. Solubility of $\text{Mg}(\text{OH})_2$ is
 (a) $4 \times 10^{-4} \text{ mol lit}^{-1}$ (b) $1 \times 10^{-12} \text{ mol lit}^{-1}$
 (c) $1 \times 10^{-4} \text{ mol lit}^{-1}$ (d) $2 \times 10^{-6} \text{ mol lit}^{-1}$
14. The pH of a simple sodium acetate buffer is given by

$$\text{pH} = \text{p}K_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

 K_a of acetic acid = 1.8×10^{-5}
 If $[\text{Salt}] = [\text{Acid}] = 0.1 \text{ M}$, the pH of the solution would be about
 (a) 7 (b) 4.7 (c) 5.3 (d) 1.4
15. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : The equilibrium constant does not change on addition of catalyst.
Reason (R) : A catalyst provides an alternative path of lower activation energy for conversion of reactants to products.
 Select the most appropriate answer from the options given below:
 (a) Both A and R are true and R is the correct explanation of A.
 (b) Both A and R are true but R is not the correct explanation of A.
 (c) A is true but R is false.
 (d) A is false but R is true.
16. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : At 25°C the pH of 10^{-7} M HCl is 6.69.
Reason (R) : pH of acidic solution is always below 7 at 25°C .
 Select the most appropriate answer from the options given below:
 (a) Both A and R are true and R is the correct explanation of A.
 (b) Both A and R are true but R is not the correct explanation of A.
 (c) A is true but R is false.
 (d) A is false but R is true.
17. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : The value of K_w at 25°C is $1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$.
Reason (R) : K_w of water changes with change in temperature.
 Select the most appropriate answer from the options given below:
 (a) Both A and R are true and R is the correct explanation of A.
 (b) Both A and R are true but R is not the correct explanation of A.
 (c) A is true but R is false.
 (d) A is false but R is true.

18. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion (A) : H_3PO_4 is a stronger acid than H_2PO_4^- .

Reason (R) : $\text{p}K_{a_1}$ is greater than $\text{p}K_{a_2}$ for H_3PO_4 .

Select the most appropriate answer from the options given below:

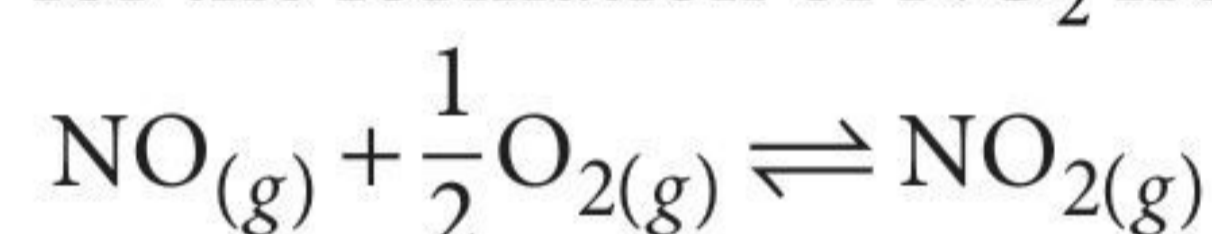
- Both A and R are true and R is the correct explanation of A.
- Both A and R are true but R is not the correct explanation of A.
- A is true but R is false.
- A is false but R is true.

SECTION B

This section contains 7 questions with internal choice in two questions. The following questions are very short answer type and carry 2 marks each.

19. Differentiate between homogeneous and heterogeneous equilibrium giving examples.

20. Calculate (a) ΔG° and (b) the equilibrium constant for the formation of NO_2 from NO and O_2 at 298 K.



where $\Delta_f G^\circ (\text{NO}_2) = 52.0 \text{ kJ mol}^{-1}$,

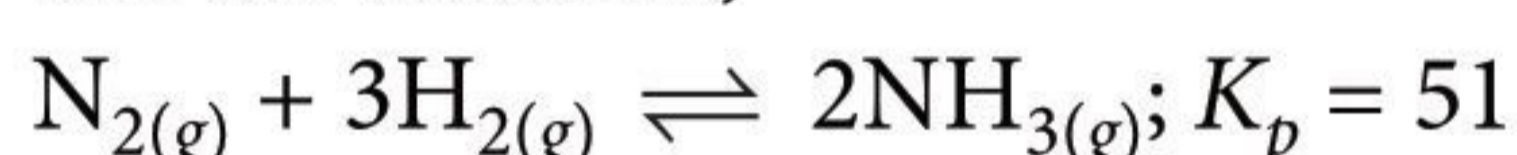
$\Delta_f G^\circ (\text{NO}) = 87.0 \text{ kJ mol}^{-1}$,

$\Delta_f G^\circ (\text{O}_2) = 0 \text{ kJ mol}^{-1}$

OR

The ionization constant of HF , HCOOH and HCN at 298 K are 6.8×10^{-4} , 1.8×10^{-4} and 4.8×10^{-9} respectively. Calculate the ionization constants of the corresponding conjugate base.

21. For the reaction,

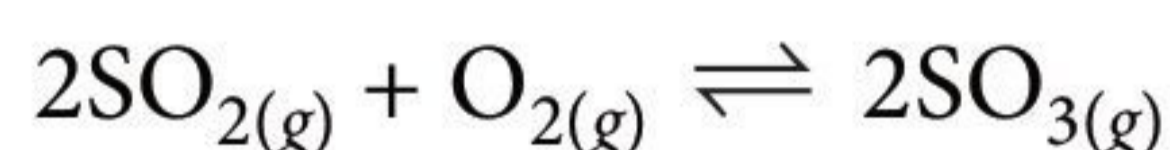


Find the value of K_p for the reaction,



OR

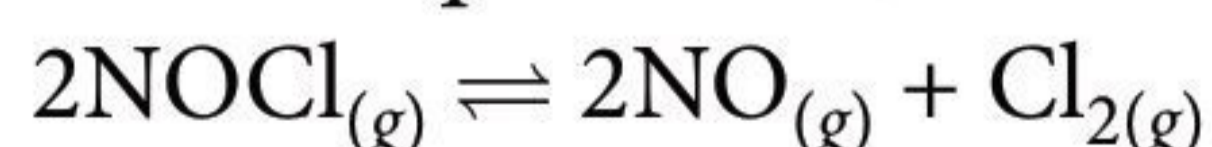
At 450 K; $K_p = 2.0 \times 10^{10} \text{ bar}^{-1}$ for the given reaction at equilibrium :



What is K_c at this temperature?

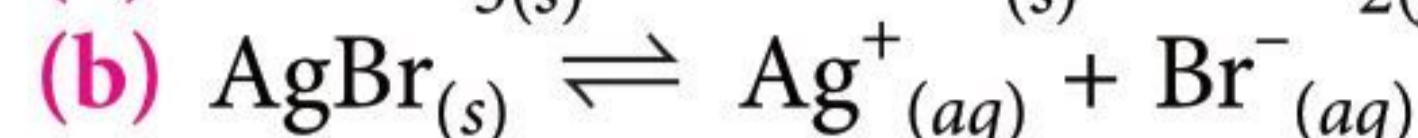
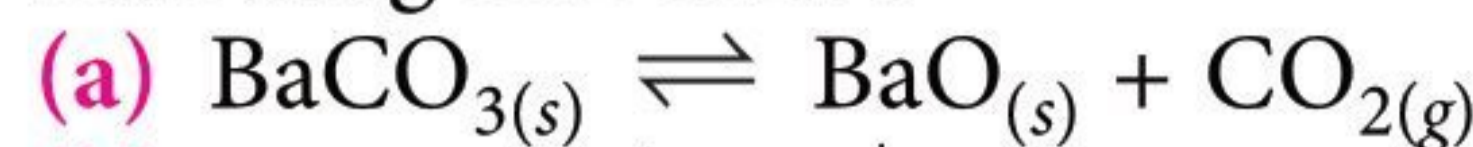
22. Derive the relationship between K_c and K_p .

23. For the equilibrium,



the value of equilibrium constant, K_c is 3.75×10^{-6} at 1069 K. Calculate K_p for the reaction at this temperature.

24. Write the equilibrium constant expressions for the following reactions :

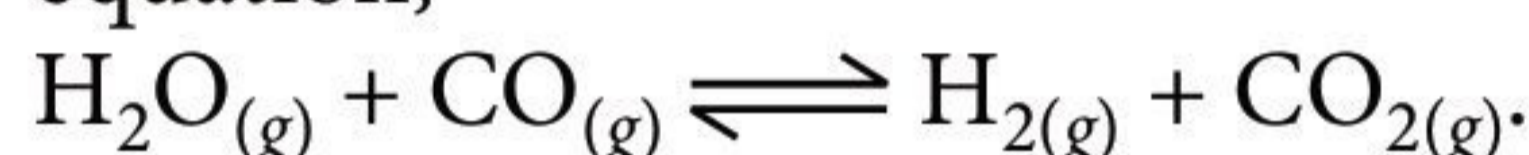


25. A vessel at 1000 K contains CO_2 with a pressure of 0.5 atm. Some of the CO_2 is converted into CO on addition of graphite. Calculate the value of K_p , if total pressure at equilibrium is 0.8 atm.

SECTION C

This section contains 5 questions with internal choice in two questions. The following questions are short answer type and carry 3 marks each.

26. One mole of H_2O and one mole of CO are taken in 10 L vessel and heated to 725 K. At equilibrium 40% of water (by mass) reacts with CO according to the equation,



Calculate the equilibrium constant for the reaction.

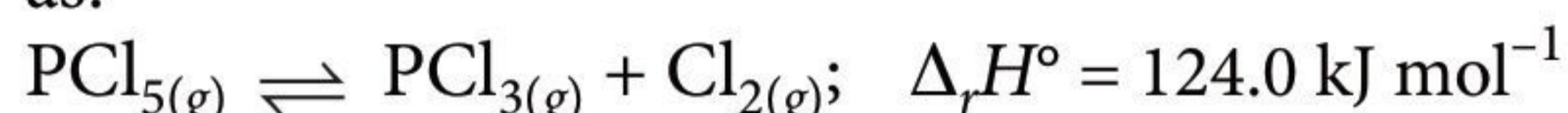
27. An equilibrium mixture at 300 K contains N_2O_4 and NO_2 at 0.28 atm and 1.1 atm pressure respectively. If the volume of the container is doubled, calculate the new equilibrium pressure of two gases.

OR

For the reaction, $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightleftharpoons 2\text{NH}_{3(g)}$ the value of K_p is 3.6×10^{-2} at 500 K. Calculate the value of K_c for the reaction at the same temperature. $R = 0.083 \text{ L bar K}^{-1} \text{ mol}^{-1}$.

28. (a) Define Lewis acids and bases with example.
(b) The value of K_{sp} of two sparingly soluble salts $\text{Ni}(\text{OH})_2$ and AgCN are 2×10^{-15} and 6×10^{-17} . Which salt is more soluble and why?

29. At 473 K, equilibrium constant, K_c for decomposition of PCl_5 is 8.3×10^{-3} . If decomposition is depicted as:



- Write an expression for K_c for the reaction.
- What is the value of K_c for the reverse reaction at same temperature?
- What would be the effect on K_c if
 - the pressure is increased
 - the temperature is increased?

30. Give reasons for **any three** of the following:

- NH_3 is termed as a base though it does not contain OH^- ions.
- SO_3^{2-} is a bronsted base.
- CO_2 is more soluble in aqueous NaOH than in water.
- Pure liquids and solids can be ignored while writing the equilibrium constant expression.

SECTION D

The following questions are case-based questions. Each question has an internal choice and carries 4 (1+1+2) marks each. Read the passage carefully and answer the questions that follow.

31. For a reversible reaction,



$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}; \text{ where, } K_c \text{ is equilibrium constant.}$$

K_c is specific for a reaction and this equilibrium equation is also known as law of mass action.

At a given temperature, the product of concentrations of the reaction products raised to the respective stoichiometric coefficient in the balanced chemical equation divided by the product of concentrations of the reactants raised to their individual stoichiometric coefficients has a constant value. This is known as the equilibrium law or law of chemical equilibrium.

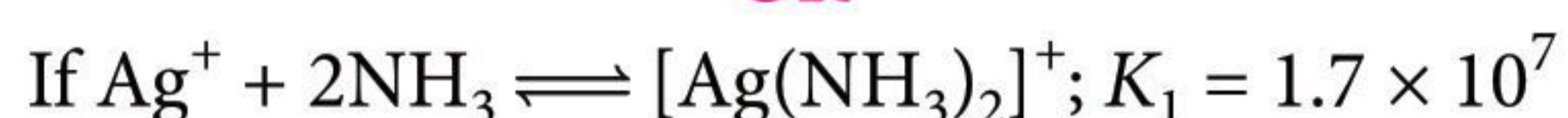
Relations between equilibrium constants for a general reaction and its multiples :

Chemical equation	Equilibrium constant
$aA + bB \rightleftharpoons cC + dD$	K_c
$cC + dD \rightleftharpoons aA + bB$	$K'_c = (1/K_c)$
$naA + nbB \rightleftharpoons ncC + ndD$	$K''_c = (K_c)^n$

Answer the following questions:

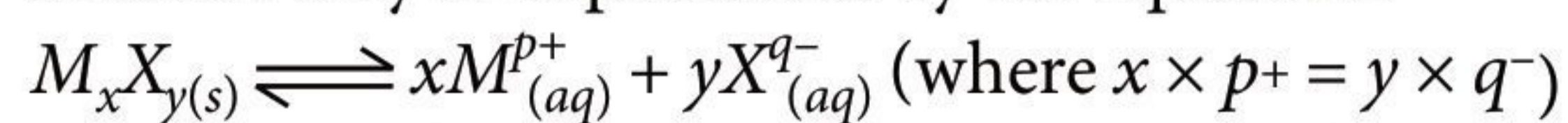
- (a) What is K_c for the following equilibrium when the equilibrium concentration of each substance is $[SO_2] = 0.60 \text{ M}$, $[O_2] = 0.82 \text{ M}$ and $[SO_3] = 1.90 \text{ M}$?
- $$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$
- (b) Equilibrium constant for the reaction is 4.0. What will be the equilibrium constant for the reverse reaction?
- (c) The following concentrations were obtained for the formation of NH_3 from N_2 and H_2 at equilibrium at 500 K.
- $[N_2] = 1.5 \times 10^{-2} \text{ M}$; $[H_2] = 3 \times 10^{-2} \text{ M}$;
 $[NH_3] = 1.2 \times 10^{-2} \text{ M}$. Calculate the equilibrium constant.

OR



Then for $AgCl + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]^+ + Cl^-$, what will be the value of equilibrium constant?

32. A solid salt of the general formula, $M_x^{p+} X_y^{q-}$ with molar solubility 's' in equilibrium with its saturated solution may be represented by the equation :



and its solubility product constant is given by :

$$K_{sp} = [M^{p+}]^x [X^{q-}]^y = (xs)^x (ys)^y = x^x \cdot y^y \cdot s^{(x+y)}$$

$$s^{(x+y)} = K_{sp} / x^x \cdot y^y$$

$$s = (K_{sp} / x^x \cdot y^y)^{1/(x+y)}$$

K_{sp} is given by Q_{sp} , when the concentration of one or more species is not the concentration under equilibrium, and under equilibrium conditions $K_{sp} = Q_{sp}$.

Answer the following questions:

- (a) If the solubility product of lead iodide (PbI_2) is 3.2×10^{-8} , then what will be its solubility?
- (b) What is the expression for K_{sp} of Ag_2CrO_4 ?
- (c) Mention one application of solubility product.

OR

What is the minimum volume of water required to dissolve 1 g of calcium sulphate at 298 K? (For calcium sulphate, K_{sp} is 9.1×10^{-6})

SECTION E

The following questions are long answer type and carry 5 marks each. Two questions have an internal choice.

33. (a) Point out the differences between ionic product and solubility product.
- (b) The solubility of $AgCl$ in water at 298 K is $1.06 \times 10^{-5} \text{ mol per litre}$. Calculate its solubility product at this temperature .

OR

- (a) What is common ion effect?
- (b) Write the K_{sp} expressions for Ag_2CrO_4 and zirconium phosphate.
- (c) Calculate the pH of 0.005 M HCl solution.
34. (a) Define Le-Chatelier principle. What is the effect of (i) addition of H_2 , (ii) removal of CO on the equilibrium of the following reaction?
- $$2H_{2(g)} + CO_{(g)} \rightleftharpoons CH_3OH_{(g)}$$
- (b) Equal volumes of 0.002 M solutions of sodium iodate ($NaIO_3$) and cupric chlorate [$Cu(ClO_4)_2$] are mixed together. Will it lead to the precipitation of cupric iodate [$Cu(IO_3)_2$]?
- $\{K_{sp}[Cu(IO_3)_2] = 7.4 \times 10^{-8}\}$

OR

- (a) Write conjugate acid and conjugate base of H_2O and HSO_4^- .
 (b) What is the limitation of Arrhenius theory?
 (c) At equilibrium, the concentration of $\text{N}_2 = 3.0 \times 10^{-4} \text{ M}$, $\text{O}_2 = 4.2 \times 10^{-4} \text{ M}$ and $\text{NO} = 2.8 \times 10^{-4} \text{ M}$. What will be K_c for the reaction, $\text{N}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{NO}_{(g)}$?

35. (a) Derive the relationship between $\text{p}K_w$, pH and pOH starting from ionisation constant of water, K_w . What is the numerical value of $\text{p}K_w$ at 298 K?
 (b) If 0.561 g of KOH is dissolved in water to give 200 mL of solution at 298 K. Calculate the concentrations of K^+ and OH^- . What is its pH ? (Give atomic masses $\text{K} = 39$, $\text{O} = 16$, $\text{H} = 1$)

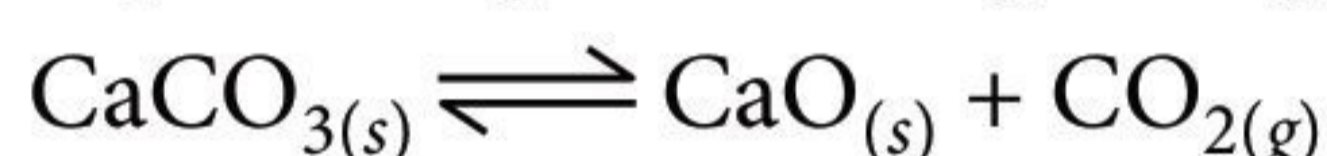
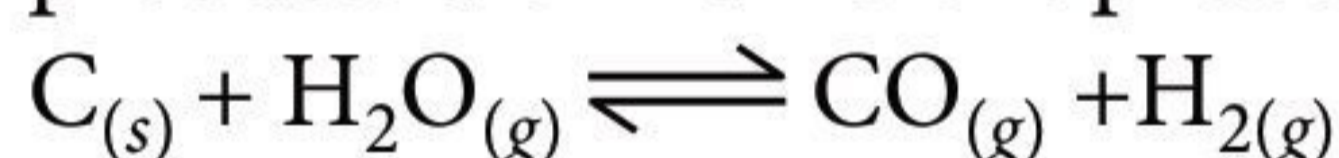
SOLUTIONS

1. (a) 2. (b)
 3. (d): $\Delta n = 0$, hence, $K_p = K_c$
 4. (c) 5. (a) 6. (c) 7. (c) 8. (d)
 9. (d): Exothermic reaction, decrease in number of moles, increase in concentration of reactants.
 10. (d) 11. (d) 12. (c) 13. (c) 14. (b)
 15. (b) 16. (a) 17. (b) 18. (c)

19. Equilibrium is said to be homogeneous if reactants and products are in same phase, e.g.,



Equilibrium is said to be heterogeneous if reactants and products are in different phases, e.g.,



20. $\Delta G^\circ = \Delta_f G^\circ(\text{NO}_2) - [\Delta_f G^\circ(\text{NO}) + \frac{1}{2} \Delta_f G^\circ(\text{O}_2)]$
 $= 52.0 - 87.0 - \frac{1}{2} \times 0 = -35 \text{ kJ mol}^{-1}$
 $\log K = -\frac{\Delta G^\circ}{2.303 RT}$
 $= -\frac{-35 \times 10^3 \text{ J mol}^{-1}}{2.303 \times 8.314 \text{ J K}^{-1} \text{ mol}^{-1} \times 298 \text{ K}} = 6.314$
 or $K = 2.06 \times 10^6$

OR

For F^- , $K_b = \frac{K_w}{K_a} = \frac{10^{-14}}{6.8 \times 10^{-4}} = 1.47 \times 10^{-11}$

For HCOO^- , $K_b = \frac{10^{-14}}{1.8 \times 10^{-4}} = 5.6 \times 10^{-11}$

For CN^- , $K_b = \frac{10^{-14}}{4.8 \times 10^{-9}} = 2.08 \times 10^{-6}$

21. $K_p = \frac{(p_{\text{NH}_3})^2}{(p_{\text{N}_2})(p_{\text{H}_2})^3} = 51$

$$K'_p = \frac{(p_{\text{N}_2})(p_{\text{H}_2})^3}{(p_{\text{NH}_3})^2} = \frac{1}{K_p} = \frac{1}{51} = 0.0196$$

OR

$$K_p = K_c(RT)^{\Delta n_g} \text{ or } K_c = \frac{K_p}{(RT)^{\Delta n_g}}$$

$$\Delta n_g = 2 - (2 + 1) = -1, T = 450 \text{ K},$$

$$R = 0.083 \text{ bar L K}^{-1} \text{ mol}^{-1}$$

$$\therefore K_c = \frac{2.0 \times 10^{10}}{(0.083 \times 450)^{-1}} = 2.0 \times 10^{10} \times (0.083 \times 450) = 7.47 \times 10^{11} \text{ L mol}^{-1}$$

22. $aA + bB \rightleftharpoons cC + dD$

$$K_p = \frac{(p_C^c)(p_D^d)}{(p_A^a)(p_B^b)} = \frac{[C]^c[D]^d(RT)^{(c+d)}}{[A]^a[B]^b(RT)^{(a+b)}}$$

$$= \frac{[C]^c[D]^d}{[A]^a[B]^b} (RT)^{(c+d)-(a+b)}$$

$$= \frac{[C]^c[D]^d}{[A]^a[B]^b} (RT)^{\Delta n_g} = K_c(RT)^{\Delta n_g}$$

where, $\Delta n_g = (\text{number of moles of gaseous products}) - (\text{number of moles of gaseous reactants})$ in the balanced chemical equation.

23. $K_p = K_c(RT)^{\Delta n_g}$; $\Delta n_g = 3 - 2 = 1$

$$\therefore K_p = 3.75 \times 10^{-6} \times (0.083 \times 1069) = 3.3272 \times 10^{-4}$$

24. (a) $K_c = \frac{[\text{BaO}_{(s)}][\text{CO}_{2(g)}]}{[\text{BaCO}_{3(s)}]}$

By convention, $[\text{BaO}_{(s)}] = 1$ and $[\text{BaCO}_{3(s)}] = 1$

$$\therefore K_c = [\text{CO}_{2(g)}] \text{ or } K_p = p_{(\text{CO}_2)}$$

(b) $K_c = \frac{[\text{Ag}^+_{(aq)}][\text{Br}^-_{(aq)}]}{[\text{AgBr}_{(s)}]}$

or $K_c = [\text{Ag}^+_{(aq)}][\text{Br}^-_{(aq)}]$ ($\because [\text{AgBr}_{(s)}] = 1$)



Pressure before reaction : 0.5 atm 0

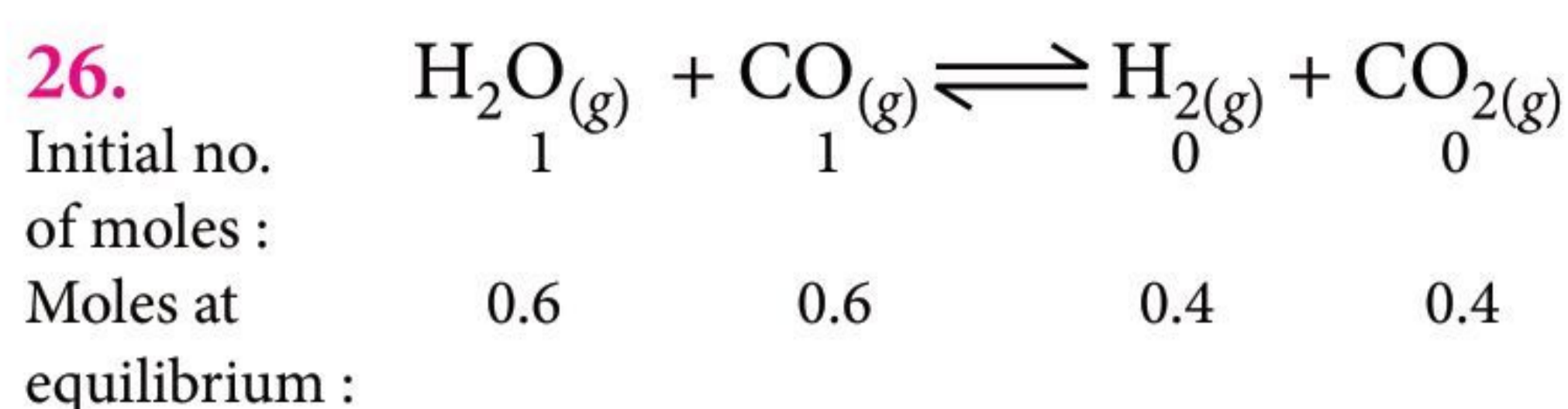
Pressure at equilibrium : $(0.5 - p) \text{ atm}$ $2p \text{ atm}$

Total pressure = $0.5 - p + 2p$

$$0.8 = 0.5 - p + 2p$$

$$\therefore p = 0.3 \text{ atm}$$

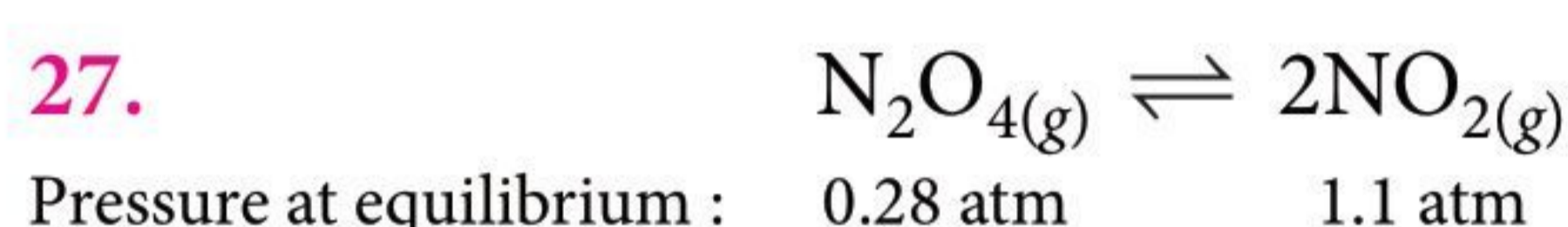
Hence, $K_p = \frac{(p_{\text{CO}})^2}{p_{\text{CO}_2}} = \frac{(2 \times 0.3)^2}{(0.5 - 0.3)} = 1.8 \text{ atm}$



$$\therefore [\text{H}_2\text{O}] = \frac{0.6}{10} \text{ mol L}^{-1}; [\text{CO}] = \frac{0.6}{10} \text{ mol L}^{-1}$$

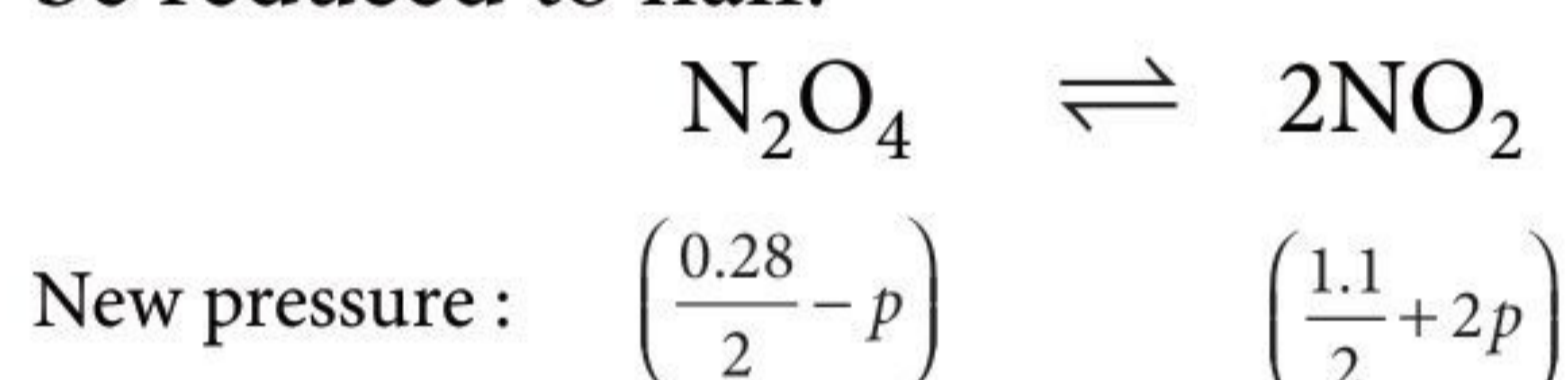
$$[\text{H}_2] = \frac{0.4}{10} \text{ mol L}^{-1} \text{ and } [\text{CO}_2] = \frac{0.4}{10} \text{ mol L}^{-1}$$

$$K_c = \frac{[\text{H}_2][\text{CO}_2]}{[\text{H}_2\text{O}][\text{CO}]} = \frac{\frac{0.4}{10} \times \frac{0.4}{10}}{\frac{0.6}{10} \times \frac{0.6}{10}} = 0.44$$



$$K_p = \frac{p_{(\text{NO}_2)}^2}{p_{(\text{N}_2\text{O}_4)}} = \frac{(1.1)^2}{(0.28)} = 4.32 \text{ atm}$$

If volume of the container is doubled the pressure will be reduced to half.



$$K_p = \frac{\left(\frac{1.1}{2} + 2p\right)^2}{\left(\frac{0.28}{2} - p\right)} = 4.32$$

On solving, $p = 0.045 \text{ atm}$

$$\therefore p_{(\text{N}_2\text{O}_4)} = 0.14 - 0.045 = 0.095 \text{ atm}$$

$$p_{(\text{NO}_2)} = 0.55 + 0.045 \times 2 = 0.64 \text{ atm}$$

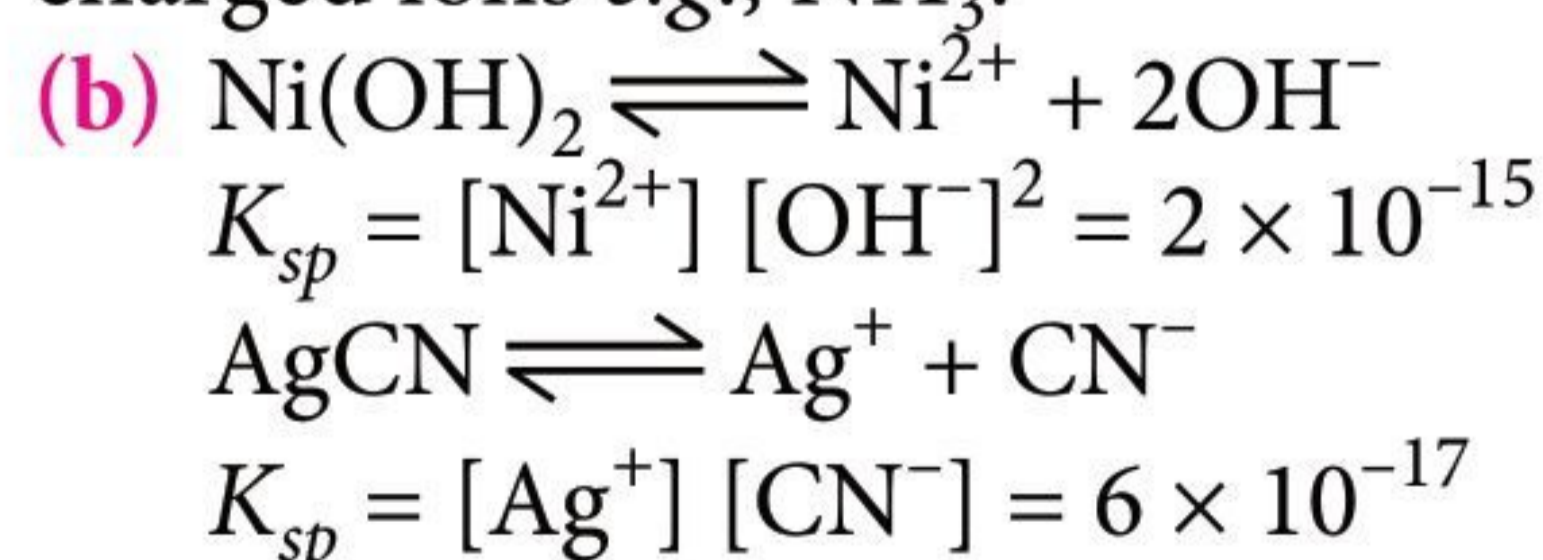
OR

The relation between K_p and K_c is $K_p = K_c(RT)^{\Delta n_g}$
 $\Delta n_g = 2 - 4 = -2$

$$K_c = \frac{K_p}{(RT)^{\Delta n_g}} = \frac{3.6 \times 10^{-2}}{(0.083 \times 500)^{-2}}$$

$$= 3.6 \times 10^{-2} \times (0.083 \times 500)^2 = 62$$

28. (a) Lewis acids are those which can accept a pair of electrons or negatively charged ions e.g., BCl_3 . Lewis bases can donate a pair of electrons or negatively charged ions e.g., NH_3 .



Suppose $[\text{Ag}^+] = [\text{CN}^-] = s_1$ and $[\text{Ni}^{2+}] = s_2$

Hence, $[\text{OH}^-] = 2s_2$

$$\text{Since, } s_1^2 = 6 \times 10^{-17} \Rightarrow s_1 = \sqrt{60 \times 10^{-18}}$$

$$\Rightarrow s_1 = 7.7 \times 10^{-9} \text{ M}$$

$$\text{Since, } s_2 \times (2s_2)^2 = 2 \times 10^{-15} \Rightarrow 4s_2^3 = 2 \times 10^{-15}$$

$$\Rightarrow s_2^3 = 0.5 \times 10^{-15} \Rightarrow s_2^3 = 5 \times 10^{-16}$$

$$\Rightarrow s_2^3 = 500 \times 10^{-18}$$

$$\Rightarrow s_2 = \sqrt[3]{500 \times 10^{-18}} = 7.9 \times 10^{-6} \text{ M}$$

Since $s_2 > s_1$, therefore $\text{Ni}(\text{OH})_2$ is more soluble than AgCN .



(b) For the reverse reaction

$$K_c = \frac{1}{K_c \text{ for the forward reaction}} = \frac{1}{8.3 \times 10^{-3}} = 120.48$$

(c) (i) When pressure increases, K_c remains unchanged.
(ii) K_c increases with increase in temperature because the reaction is endothermic.

30. (i) The basic nature of ammonia is due to its tendency to donate electron pair. So, it is a Lewis base.

(ii) SO_3^{2-} is a Bronsted base as it can accept H^+ ion.

(iii) When CO_2 is dissolved in water, dissociates as :
 $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HCO}_3^- + \text{H}^+$

On adding an alkali such as NaOH , it will react with the H^+ ions, thus reducing their concentration. The equilibrium will try to raise the concentration of H^+ ions to their former level. Thus, more CO_2 is dissolved.

(iv) For the concentration of pure solid or pure liquid,

$$\text{Molar conc.} = \frac{\text{Moles of the substance}}{\text{Volume of the substance}}$$

$$= \frac{\text{Mass}}{\text{Volume}} \times \frac{1}{\text{Molar mass}} = \frac{\text{Density}}{\text{Molar mass}}$$

Since density of pure solid or liquid is constant at constant temperature and molar mass is also constant therefore, their molar concentrations are constant and are included in the equilibrium constant.

31. (a) Applying law of chemical equilibrium,

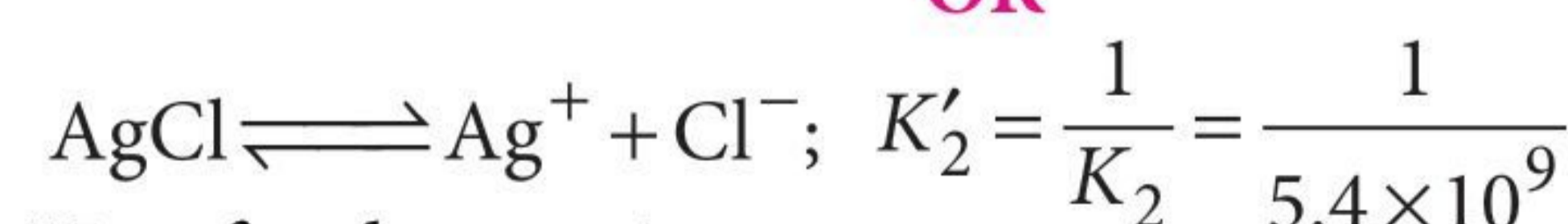
$$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]} = \frac{(1.90)^2}{(0.6)^2(0.82)} = 12.229 \text{ L mol}^{-1}$$

(b) $K'_c = \frac{1}{K_c} = \frac{1}{4.0} = 0.25$

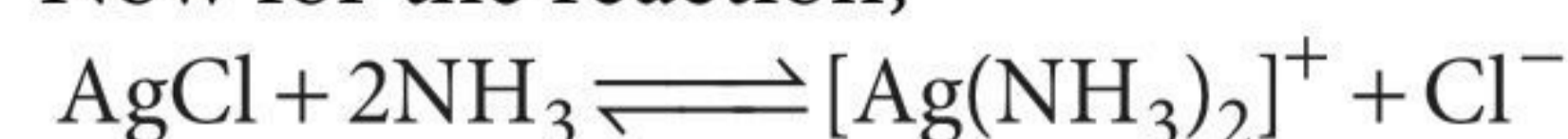
(c) $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightleftharpoons 2\text{NH}_{3(g)} ; K_c = \frac{[\text{NH}_{3(g)}]^2}{[\text{N}_{2(g)}][\text{H}_{2(g)}]^3}$

$$= \frac{(1.2 \times 10^{-2})^2}{(1.5 \times 10^{-2})(3 \times 10^{-2})^3} = \frac{1.44 \times 10^{-4}}{40.5 \times 10^{-8}} = 3.55 \times 10^2$$

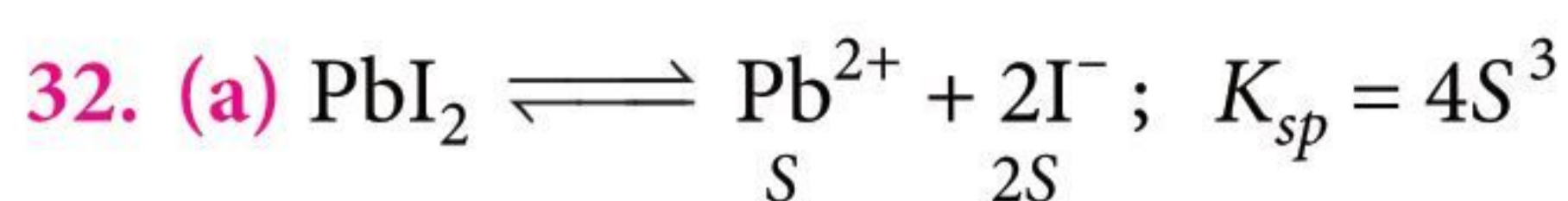
OR



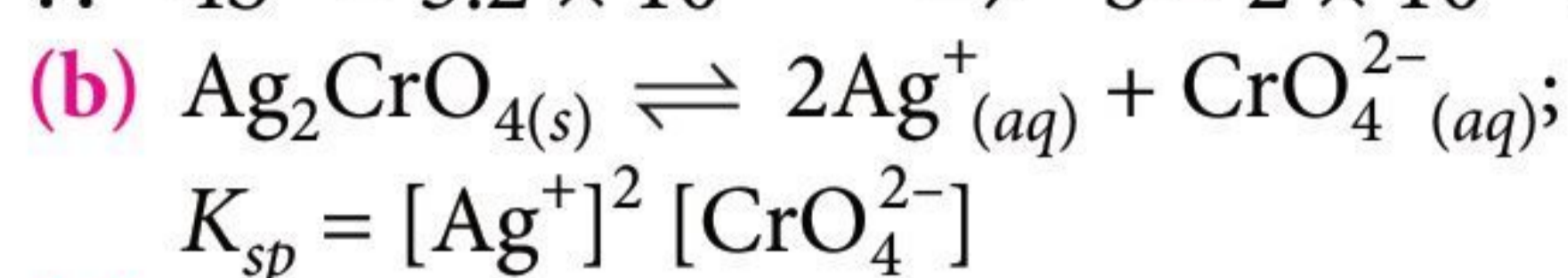
Now for the reaction,



$$K = K_1 \times K'_2 = 1.7 \times 10^7 \times \frac{1}{5.4 \times 10^9} = 0.31 \times 10^{-2}$$

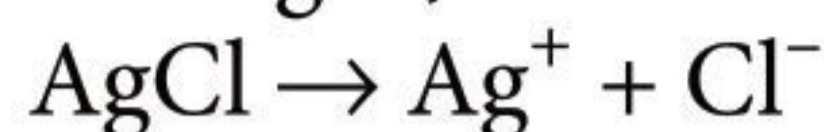


$\therefore 4S^3 = 3.2 \times 10^{-8} \Rightarrow S = 2 \times 10^{-3} \text{ M}$



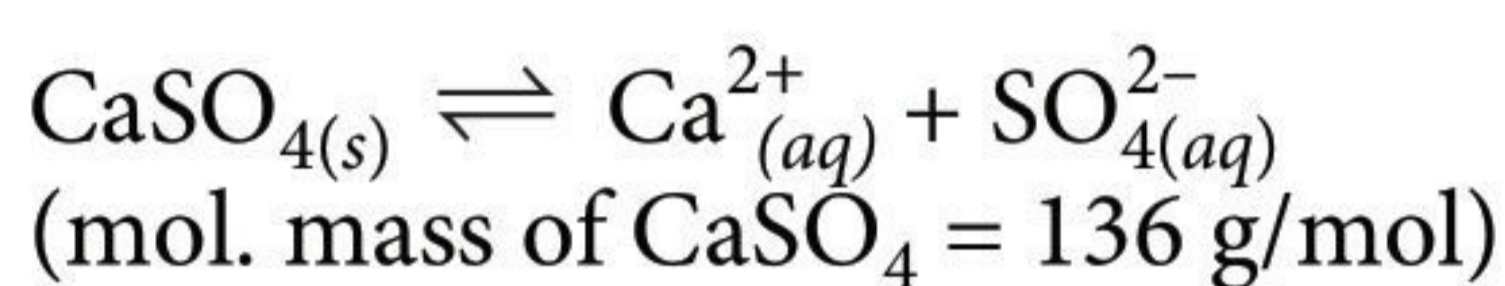
(c) In calculation of solubility of a sparingly soluble salt. For example,

For AgCl, if solubility is $S \text{ mol L}^{-1}$, then



$K_{sp} = [\text{Ag}^+] [\text{Cl}^-] = S \times S = S^2 \Rightarrow S = \sqrt{K_{sp}} \text{ mol L}^{-1}$

OR



Let the solubility of CaSO_4 in mol/L be S .

$K_{sp} = [\text{Ca}^{2+}] [\text{SO}_4^{2-}] = S^2$

$S = \sqrt{K_{sp}} = \sqrt{9.1 \times 10^{-6}}$

$= 3.02 \times 10^{-3} \text{ mol/L} = 0.411 \text{ g/L}$

For dissolving 0.411 g of CaSO_4 , water required is 1 L

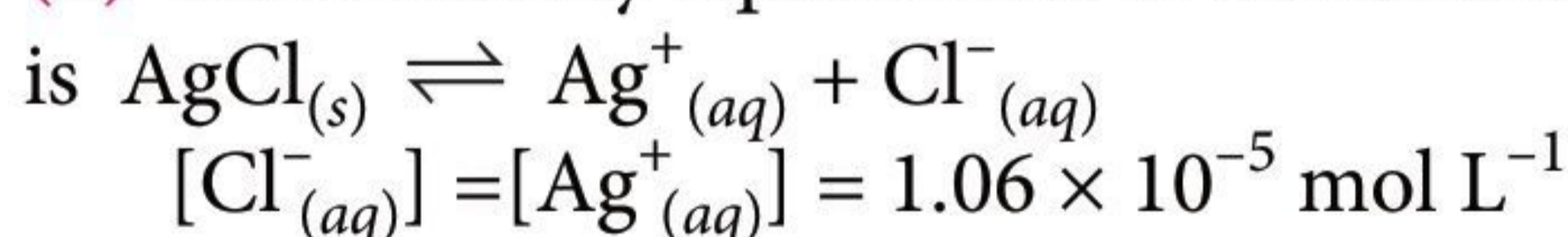
For dissolving 1 g of CaSO_4 , water required

$= \frac{1}{0.411} \text{ L} = 2.43 \text{ L}$

33. (a) The term ionic product has a broad meaning since it is applicable to all types of solutions, may be unsaturated or saturated. On the other hand, the solubility product has restricted meaning since it applies only to a saturated solution in which there exists a dynamic equilibrium between the undissolved salt and the ions present in solution. Thus, the solubility product is, in fact the ionic product for a saturated solution.

The solubility product of a salt is constant at constant temperature whereas ionic product depends upon the concentrations of ions in the solution.

(b) The solubility equilibrium in the saturated solution is



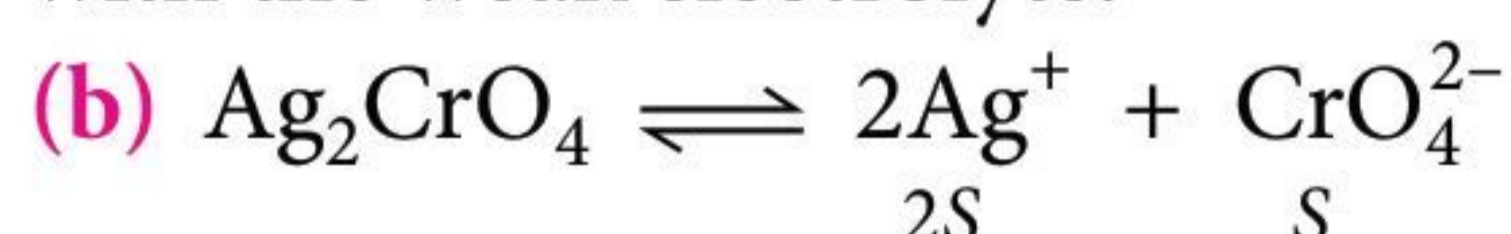
$K_{sp} = [\text{Ag}^+_{(aq)}] [\text{Cl}^-_{(aq)}]$

$= (1.06 \times 10^{-5} \text{ mol L}^{-1}) \times (1.06 \times 10^{-5} \text{ mol L}^{-1})$

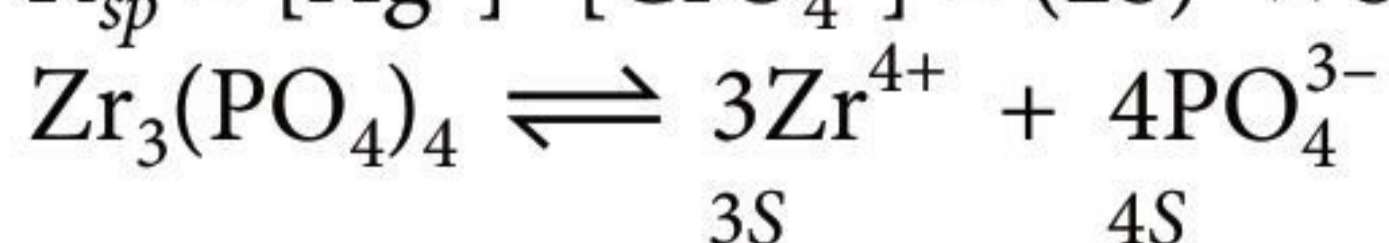
$= 1.12 \times 10^{-10} \text{ mol}^2 \text{ L}^{-2}$

OR

(a) Common ion effect can be defined as the suppression of the degree of ionisation of a weak electrolyte by the addition of a strong electrolyte having an ion common with the weak electrolyte.



$K_{sp} = [\text{Ag}^+]^2 [\text{CrO}_4^{2-}] = (2S)^2 \times S = 4S^3$



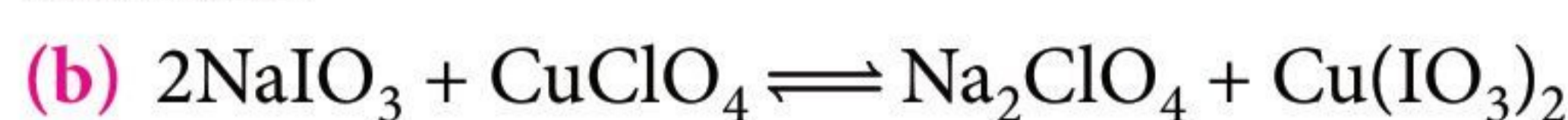
$K_{sp} = [\text{Zr}^{4+}]^3 [\text{PO}_4^{3-}]^4 = (3S)^3 \times (4S)^4 = 6912S^7$

(c) $\text{pH} = -\log [\text{H}_3\text{O}^+] = -\log (0.005) = 2.30$

34. (a) When an equilibrium is subjected to any kind of stress (change in concentration, temperature or pressure) it shifts in a direction so as to undo the effect of stress.

(i) When H_2 is added, the rate of forward reaction will increase.

(ii) Removal of CO will increase the rate of backward reaction.



After mixing, $[\text{NaIO}_3] = [\text{IO}_3^-] = (2 \times 10^{-3})/2 = 10^{-3} \text{ M}$

$[\text{CuClO}_4] = [\text{Cu}^{2+}] = (2 \times 10^{-3})/2 = 10^{-3} \text{ M}$

Ionic product of $\text{Cu}(\text{IO}_3)_2 = [\text{Cu}^{2+}] [\text{IO}_3^-]^2$

$= (10^{-3}) (10^{-3})^2 = 10^{-9}$

As ionic product is less than K_{sp} , no precipitation will occur.

OR

(a) Conjugate acid of H_2O is H_3O^+ .

Conjugate base of H_2O is OH^- .

Conjugate acid of HSO_4^- is H_2SO_4 .

Conjugate base of HSO_4^- is SO_4^{2-} .

(b) According to Arrhenius concept, an acid must contain H^+ and a base must contain OH^- groups. However, a number of substances like CO_2 , SO_2 etc. are known to be acidic but do not contain any hydrogen and similarly substances like NH_3 , Na_2CO_3 etc. are known to be basic but do not contain any hydroxyl groups.

(c) $K_c = \frac{[\text{NO}_2]}{[\text{N}_2][\text{O}_2]}$

$\therefore K_c = \frac{(2.8 \times 10^{-4} \text{ M})^2}{(3.0 \times 10^{-4} \text{ M})(4.2 \times 10^{-4} \text{ M})} = 0.622$

35. (a) Sorensen (1909) defined pH of a solution as negative logarithm of the hydrogen ion concentration of the solution.

Thus, $\text{pH} = -\log[\text{H}^+] = \log \frac{1}{[\text{H}^+]}$ or $[\text{H}^+] = 10^{-\text{pH}}$

Likewise, pOH of a solution

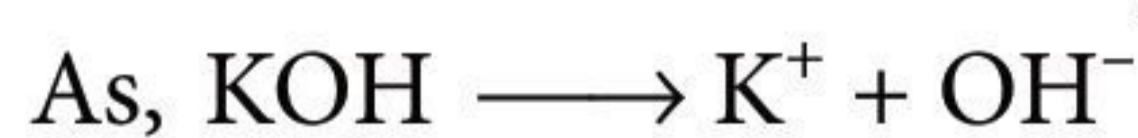
$\text{pOH} = -\log[\text{OH}^-] = \log \frac{1}{[\text{OH}^-]}$ or $[\text{OH}^-] = 10^{-\text{pOH}}$

$K_w = [\text{H}^+][\text{OH}^-]$

$= \text{Ionic product of water} = 10^{-14} (\text{mol/L})^2$

$\text{p}K_w = -\log K_w$; $\text{p}K_w = \text{pH} + \text{pOH} = 14$

(b) Molarity of KOH = $\frac{0.561}{56} \times \frac{1000}{200} = 0.05 \text{ M}$



$[\text{K}^+] = [\text{OH}^-] = 0.05 \text{ M}$

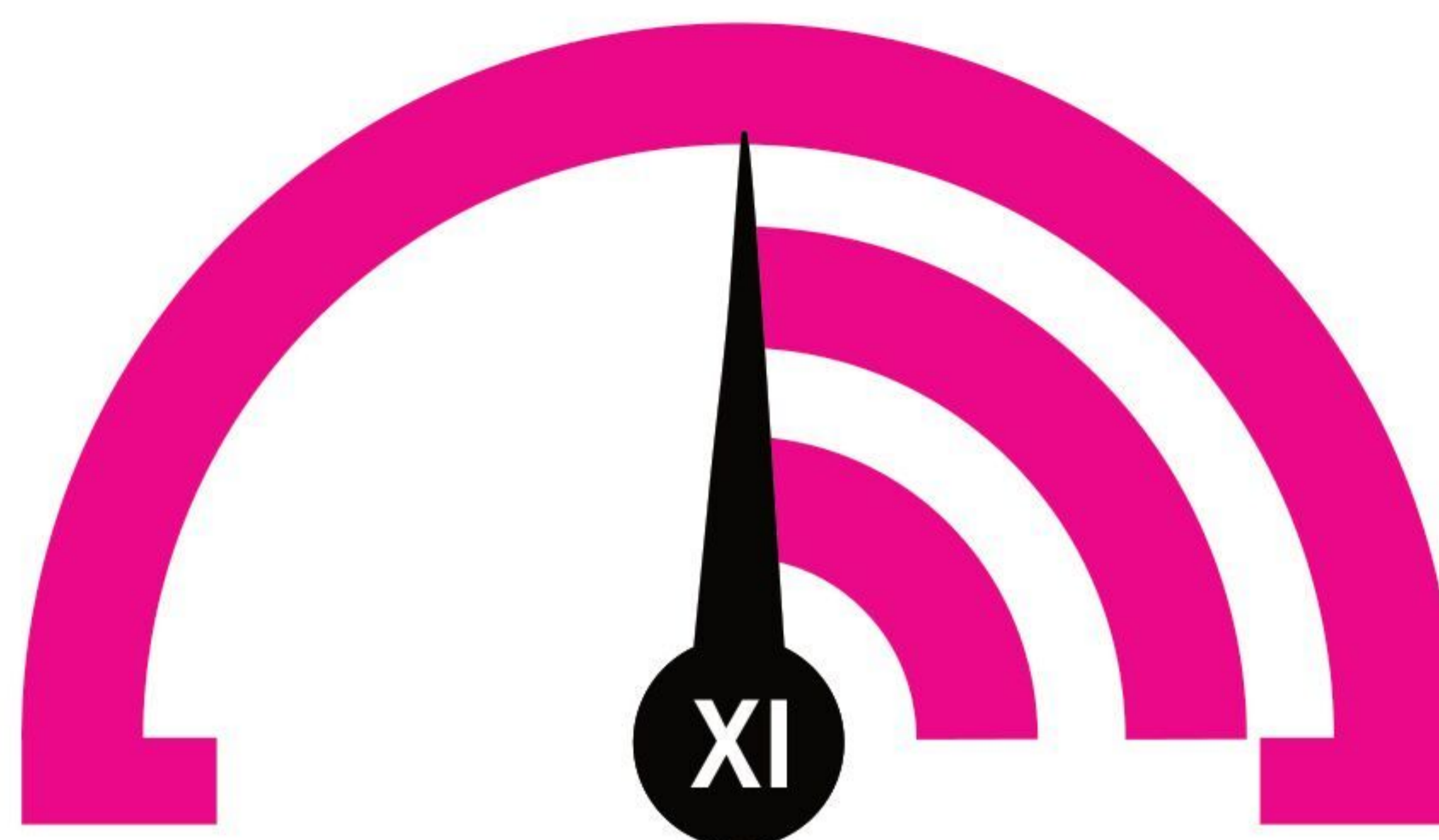
$[\text{H}^+] = K_w / [\text{OH}^-] = 10^{-14} / 0.05$

$= 10^{-14} / (5 \times 10^{-2}) = 2.0 \times 10^{-13} \text{ m}$

$\text{pH} = -\log (2 \times 10^{-13}) = 13 - \log 2 = 12.69$



MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding the specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

Hydrogen | The s-Block Elements | The p-Block Elements (Groups 13 and 14)

Time Taken : 60 Min.

NEET

Only One Option Correct Type

- Which of the following is not an isotope of hydrogen?
(a) Protium (b) *Ortho-para* hydrogen
(c) Deuterium (d) Tritium
- The ionisation energy of alkali metals decreases from Li to Cs because
(a) the atomic size increases from Li to Cs
(b) the distance between nucleus and outermost orbital decreases from Li to Cs
(c) electropositive character decreases down the group
(d) melting point decreases from Li to Cs.
- First ionisation enthalpy of Al is lower than that of Mg. This is because
(a) the size of Al is bigger than Mg
(b) ionisation enthalpy decreases in a period from left to right
(c) it is easier to remove electron from unpaired 3p-orbital than from paired 3s-orbital
(d) aluminium is a passive metal while magnesium is an active metal.
- Select the correct order of acidic character of the given hydrides?
(a) $\text{NH}_3 < \text{H}_2\text{O} < \text{HF}$ (b) $\text{HF} < \text{H}_2\text{O} < \text{NH}_3$
(c) $\text{H}_2\text{O} < \text{HF} < \text{NH}_3$ (d) $\text{H}_2\text{O} < \text{NH}_3 < \text{HF}$
- H_2O_2 can be obtained when following reacts with H_2SO_4 except with
(a) BaO_2 (b) PbO_2
(c) Na_2O_2 (d) SrO_2
- The correct increasing order of basic character of oxides MgO , SrO , K_2O and Cs_2O is
(a) $\text{MgO} < \text{SrO} < \text{K}_2\text{O} < \text{Cs}_2\text{O}$
(b) $\text{SrO} < \text{MgO} < \text{Cs}_2\text{O} < \text{K}_2\text{O}$
(c) $\text{Cs}_2\text{O} < \text{K}_2\text{O} < \text{SrO} < \text{MgO}$
(d) $\text{K}_2\text{O} < \text{Cs}_2\text{O} < \text{SrO} < \text{MgO}$
- When plaster of Paris comes in contact with water it sets into a hard mass. The composition of the hard mass is
(a) $\text{CaSO}_4 \cdot \text{H}_2\text{O}$ (b) $\text{CaSO}_4 \cdot \text{Ca}(\text{OH})_2$
(c) $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ (d) $\text{CaSO}_4 \cdot 2\text{Ca}(\text{OH})_2$
- The decreasing order of power of boron halides to act as Lewis acids is
(a) $\text{BF}_3 > \text{BCl}_3 > \text{BBR}_3$ (b) $\text{BBR}_3 > \text{BCl}_3 > \text{BF}_3$
(c) $\text{BCl}_3 > \text{BF}_3 > \text{BBR}_3$ (d) $\text{BCl}_3 > \text{BBR}_3 > \text{BF}_3$
- The tendency of group 14 elements to show +2 oxidation state increases in the order of
(a) $\text{C} < \text{Si} < \text{Sn} < \text{Pb} < \text{Ge}$
(b) $\text{C} < \text{Si} < \text{Ge} < \text{Sn} < \text{Pb}$
(c) $\text{Ge} < \text{Sn} < \text{Pb} < \text{C} < \text{Si}$
(d) $\text{Pb} < \text{Sn} < \text{Ge} < \text{C} < \text{Si}$
- Which one of the following is not the characteristic property of carbon?
(a) It exhibits catenation.
(b) It forms compounds with multiple bonds.
(c) Its melting point and boiling point are exceptionally high.
(d) It shows semi-metallic character.
- The least stable carbonate of alkali metals is
(a) Cs_2CO_3 (b) Na_2CO_3
(c) K_2CO_3 (d) Li_2CO_3
- What is the trend of boiling points of hydrides of N, O and F?
(a) Due to lower molecular masses, NH_3 , H_2O and HF have lower boiling points than those of the subsequent group member hydrides.

- (b) Due to higher electronegativity of N, O and F; NH_3 , H_2O and HF show hydrogen bonding and hence higher boiling points than the hydrides of their subsequent group members.
- (c) There is no regular trend in the boiling points of hydrides.
- (d) Due to higher oxidation states of N, O and F, the boiling points of NH_3 , H_2O and HF are higher than the hydrides of their subsequent group members.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
- (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) If assertion is true but reason is false.
- (d) If both assertion and reason are false.

13. Assertion : Soft water lathers with soap but not hard water.

Reason : Hard water reacts with soap to form insoluble salts which form scum, not lather.

14. Assertion : Lithium fluoride is the most covalent in nature.

Reason : Small anion can be easily distorted.

15. Assertion : Sn in +2 oxidation state is a reducing agent while Pb in +4 state is an oxidising agent.

Reason : Inert pair effect is due to participation of s electrons in bond formation.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

- 16.** The volume strength of 1.5 N H_2O_2 solution is
(a) 4.8 (b) 8.4 (c) 3.0 (d) 8.0
- 17.** The hydration energy of Mg^{2+} is larger than that of
(a) Al^{3+} (b) Na^+
(c) Be^{2+} (d) Mg^{3+}
- 18.** When PbO_2 reacts with concentrated HNO_3 the gas evolved is
(a) NO_2 (b) O_2
(c) N_2 (d) N_2O
- 19.** The temporary hardness of water due to calcium bicarbonate can be removed by adding
(a) CaCO_3 (b) Ca(OH)_2
(c) CaCl_2 (d) HCl

More than One Option Correct Type

- 20.** The species that do not contain peroxide ions are
(a) PbO_2 (b) H_2O_2 (c) $\text{Sr(O}_2)_2$ (d) BaO_2
- 21.** The compound(s) formed upon combustion of sodium metal in excess air is(are)
(a) Na_2O_2 (b) Na_2O (c) NaO_2 (d) NaOH .
- 22.** Highly pure dilute solution of sodium in liquid ammonia
(a) shows blue colour
(b) exhibits electrical conductivity
(c) produces sodium amide
(d) produces hydrogen gas.
- 23.** The correct statement(s) for orthoboric acid is/are
(a) it behaves as a weak acid in water due to self ionization
(b) acidity of its aqueous solution increases upon addition of ethylene glycol
(c) it has a three dimensional structure due to hydrogen bonding
(d) it is a weak electrolyte in water.

Integer / Numerical Value Type

- 24.** The hardness of a water sample containing 10^{-3} M MgSO_4 expressed as CaCO_3 equivalents (in ppm) is _____. (Molar mass of MgSO_4 is 120.37 g/mol)
- 25.** Among Li, Na, Rb, Cs, the number of metal/s which can be used as electrodes in the photoelectric cell is _____.
- 26.** Three moles of B_2H_6 are completely reacted with methanol. The number of moles of boron containing product formed is _____.

Comprehension Type

The heavier members of 13 and 14 groups, beside the group oxidation state, also show another oxidation state which is two units less than the group oxidation state. Down the group (\downarrow), the stability of higher oxidation state decreases and that of lower oxidation state increases. This concept which is commonly called inert pair effect has been used to explain many physical and chemical properties of the element of these groups.

- 27.** Which among the following is the strongest reducing agent?
(a) GaCl (b) InCl (c) BCl_3 (d) TlCl

28. The strongest reductant among the following is
(a) SnCl_2 (b) SnCl_4 (c) PbCl_2 (d) GeCl_2

Matching Type

29. Match the column I with column II and select the correct option.

	Column I		Column II
(A)	Quick lime	(i)	CaH_2
(B)	Slaked lime	(ii)	$\text{Ba}(\text{OH})_2$
(C)	Baryta water	(iii)	$\text{Ca}(\text{OH})_2$
(D)	Hydrolith	(iv)	CaO

- (a) (A) \rightarrow (i), (B) \rightarrow (ii), (C) \rightarrow (iii), (D) \rightarrow (iv)
 (b) (A) \rightarrow (iii), (B) \rightarrow (ii), (C) \rightarrow (i), (D) \rightarrow (iv)
 (c) (A) \rightarrow (i), (B) \rightarrow (iii), (C) \rightarrow (iv), (D) \rightarrow (ii)
 (d) (A) \rightarrow (iv), (B) \rightarrow (iii), (C) \rightarrow (ii), (D) \rightarrow (i)

30. Match the reactions of column I with their types given in column II and select the correct option.

	Column I		Column II
(A)	$\text{H}_2\text{O} + \text{NH}_3 \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$	(i)	Self ionisation of H_2O
(B)	$\text{FeCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{Fe}(\text{OH})_3 + 3\text{HCl}$	(ii)	Decomposition
(C)	$\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$	(iii)	Acidic nature of H_2O
(D)	$2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$	(iv)	Hydrolysis

- (a) (A) \rightarrow (ii), (B) \rightarrow (i), (C) \rightarrow (iii), (D) \rightarrow (iv)
 (b) (A) \rightarrow (iii), (B) \rightarrow (ii), (C) \rightarrow (iv), (D) \rightarrow (i)
 (c) (A) \rightarrow (i), (B) \rightarrow (ii), (C) \rightarrow (iv), (D) \rightarrow (iii)
 (d) (A) \rightarrow (iii), (B) \rightarrow (iv), (C) \rightarrow (i), (D) \rightarrow (ii)



Keys are published in this issue. Search now! ☺

SELF CHECK

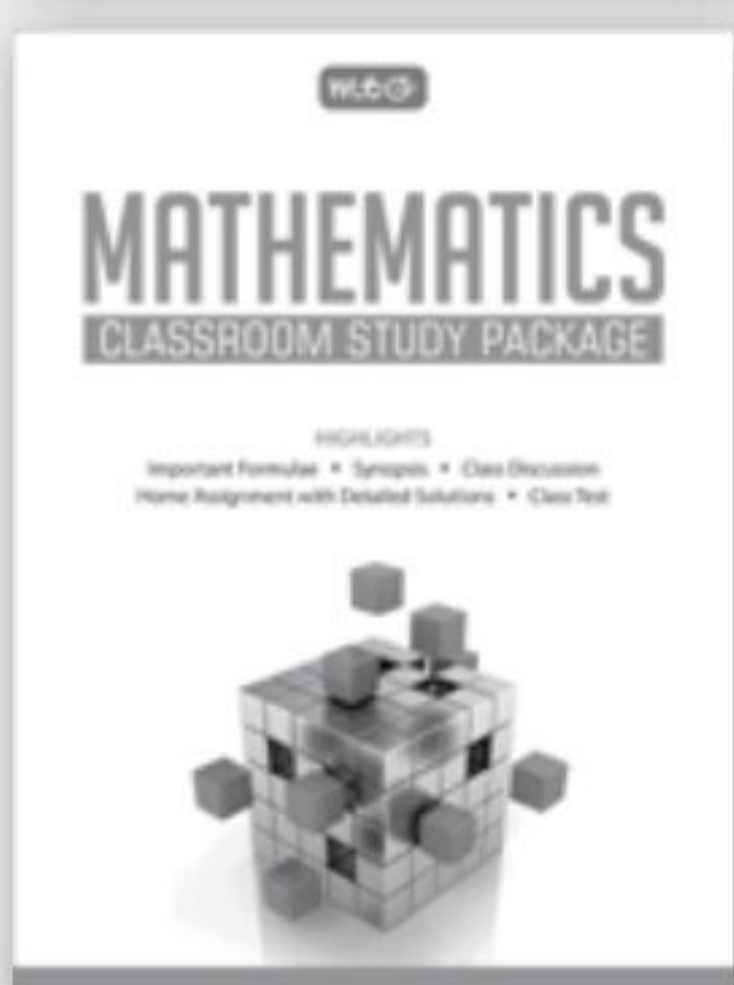
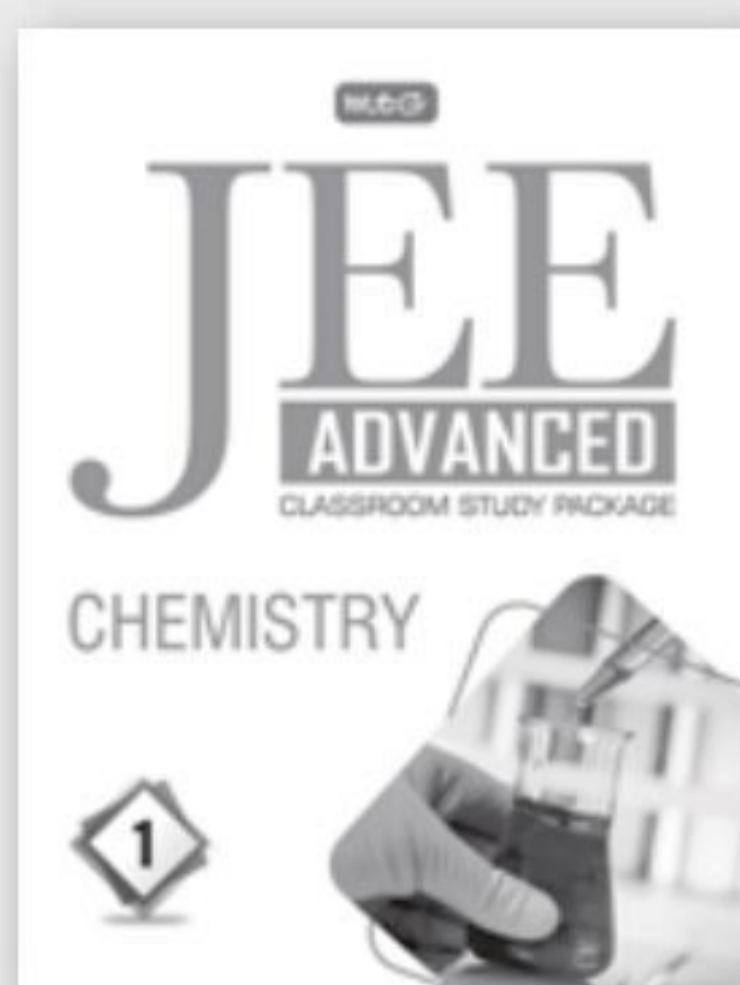
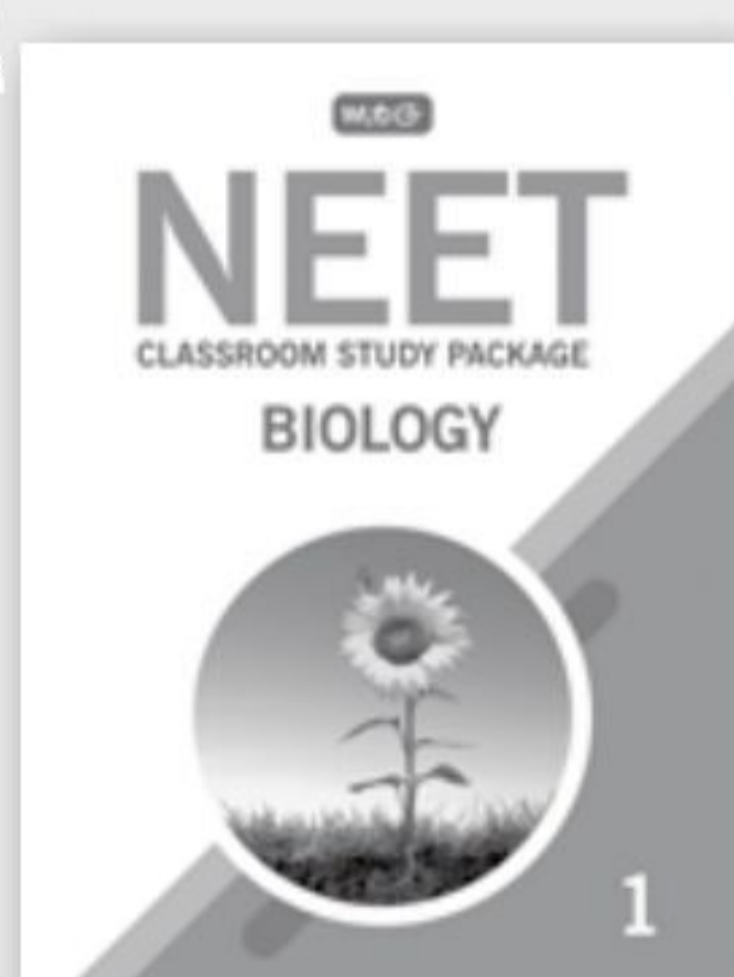
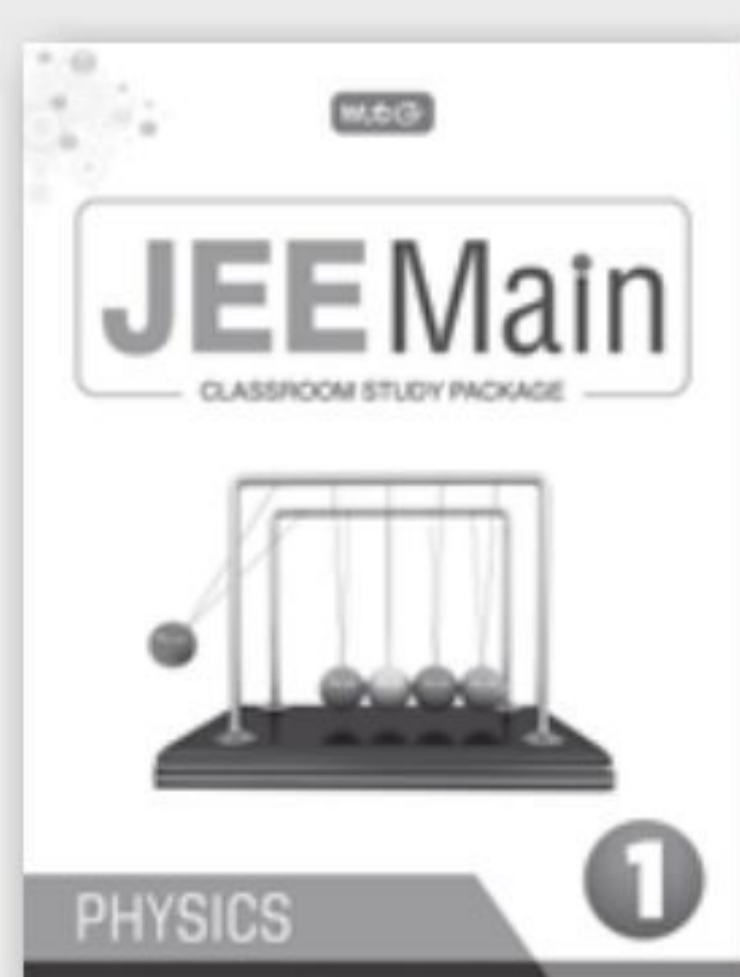
No. of questions attempted
 No. of questions correct
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Unit 3

Surface Chemistry | General Principles and Processes of Isolation of Elements

SURFACE CHEMISTRY

Surface chemistry deals with phenomena that occur at the surfaces or interfaces. The interface or surface is represented by separating the bulk phases by a hyphen or a slash.

ADSORPTION

- The phenomenon of attracting and retaining the molecules of a substance on the surface of a solid or a liquid resulting into higher concentration of the molecules on the surface than in the bulk is called **adsorption**.
- The molecular species which accumulates at the surface is known as **adsorbate** and the material on whose surface the adsorption takes place is called **adsorbent**.
- The adsorption of gases on metal surfaces is called **occlusion**.

- The process of removing an adsorbed substance from a surface on which it is adsorbed is called **desorption**.
- Both adsorption and absorption can take place simultaneously. and the process is termed as **sorption**.
- Types of adsorption** : Depending on forces which hold the adsorbate on the surface of adsorbent, adsorption is divided into two classes :
 - **Physical adsorption** : When the particles are held to the surface by the physical forces like weak van der Waals' forces, the adsorption is called physical adsorption or physisorption.
 - **Chemical adsorption** : When the particles are held to the surface by the chemical forces or by chemical bonds, the adsorption is called chemical adsorption or chemisorption.

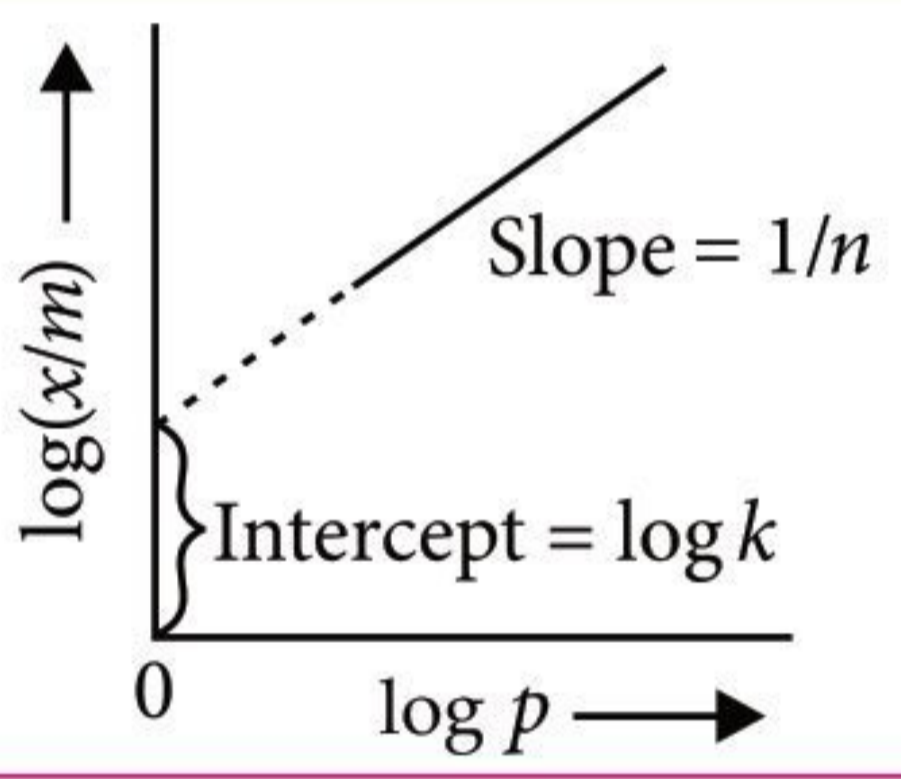
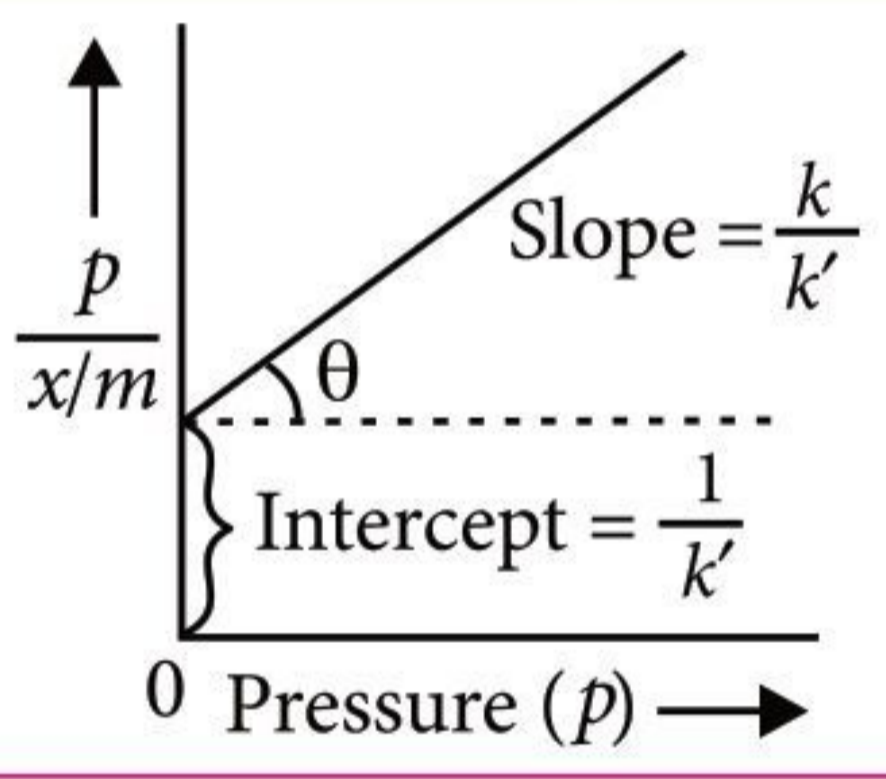
Characteristics of Adsorption

Property	Physisorption	Chemisorption
Enthalpy	Low enthalpy (20-40 kJ mol ⁻¹)	High enthalpy (80-240 kJ mol ⁻¹)
Reversibility	Reversible process	Irreversible process
Effect of temperature	With the increase in temperature, extent of adsorption decreases because adsorption is an exothermic process and kinetic energy of gas molecules increases with temperature.	Chemisorption first increases with temperature upto a certain extent and then decreases. A gas adsorbed at low temperature by physical adsorption may change into chemisorption at high temperature.
Selectivity	Not selective in nature. Does not depend upon the nature or chemical properties of gas and adsorbent.	Highly selective in nature. Depends upon the nature of gas and adsorbent.
Extent of adsorption	The extent of adsorption depends upon the ease of liquefaction of the gas.	The extent of adsorption depends upon nature of gas. Gases which react with adsorbent show chemisorption.

Activation energy	No appreciable energy needed.	High activation energy needed.
Pressure	Increase in pressure increases adsorption.	Increase in pressure decreases adsorption.
Layers	Multimolecular layer.	Unimolecular layer.

Adsorption Isotherms

- A graph representing variation between the amount of the gas adsorbed per gram of the adsorbent (x/m) and the equilibrium pressure of the adsorbate at constant temperature is called the **adsorption isotherm**.
- Difference between Freundlich Adsorption Isotherm and Langmuir Adsorption Isotherm :**

Freundlich Adsorption Isotherm	Langmuir Adsorption Isotherm
Relationship between the quantity of gas adsorbed by unit mass of solid adsorbent and pressure at a particular temperature.	On the basis of kinetic theory, Langmuir derived an expression for adsorption isotherm.
$\frac{x}{m} = k \cdot p^{1/n} (n > 1)$	$\frac{p}{(x/m)} = \frac{1}{k'} + \left(\frac{k}{k'}\right)p$
$\log \frac{x}{m} = \log k + \frac{1}{n} \log p$	$\frac{x}{m} = \frac{k'p}{1 + kp}$
	
The factor $1/n$ can have values between 0 and 1.	When pressure is very high then $1 + kp \approx kp$ $\Rightarrow \frac{x}{m} = \frac{k'p}{kp} = \text{constant}$
When $1/n = 0$, $x/m = \text{constant}$ which shows that adsorption is independent of pressure.	When pressure is very high then $1 + kp \approx 1$ $\Rightarrow x/m = k'p$
When $1/n = 1$, $x/m = kp$, $\frac{x}{m} \propto p$, the adsorption varies directly with pressure.	When pressure is moderate then $x/m = kp^{1/n}$, $1/n$ lies between 0 and 1.

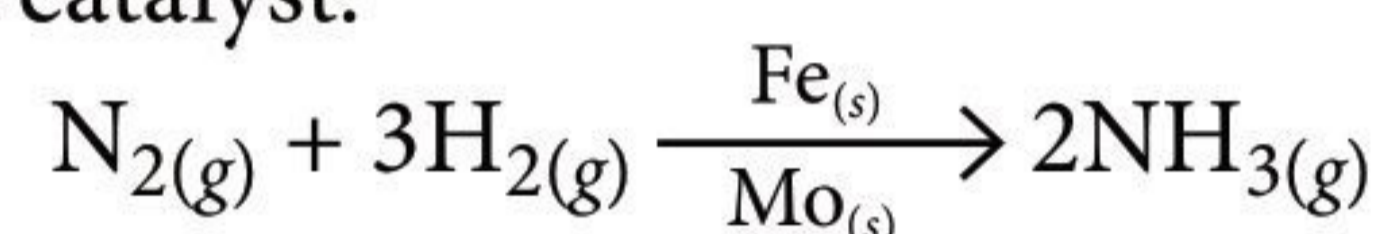
- Freundlich equation does not apply to adsorption of gases at higher pressure.

CATALYSIS

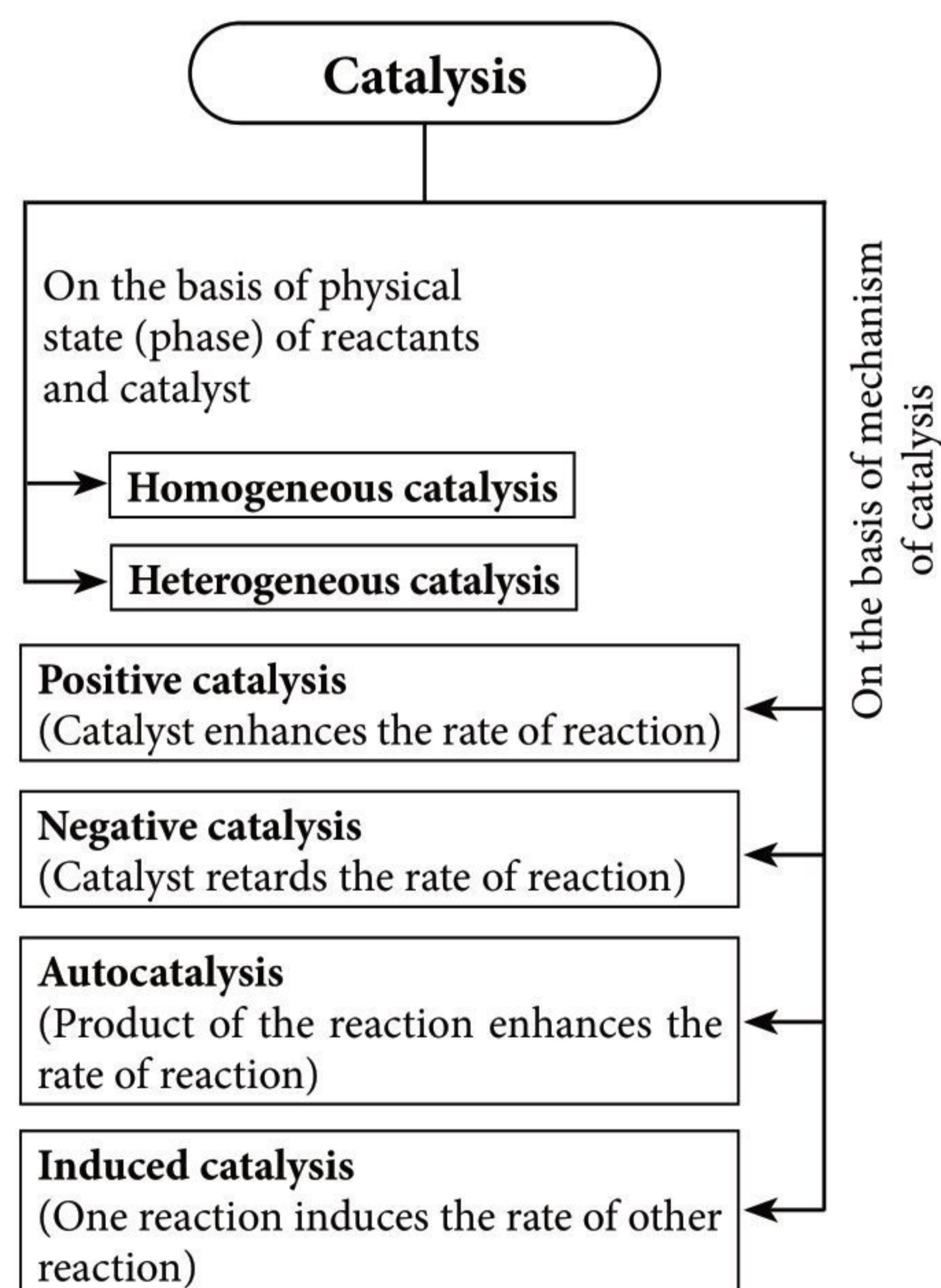
- Substances which accelerate the rate of a chemical reaction and themselves remain chemically and

quantitatively unchanged after the reaction, are known as **catalysts**, and the phenomenon is known as **catalysis**.

- Promoters and poisons :** Promoters are substances that enhance the activity of a catalyst while poisons decrease the activity of a catalyst. For example, in Haber's process for manufacture of ammonia, molybdenum acts as a promoter for iron which is used as a catalyst.

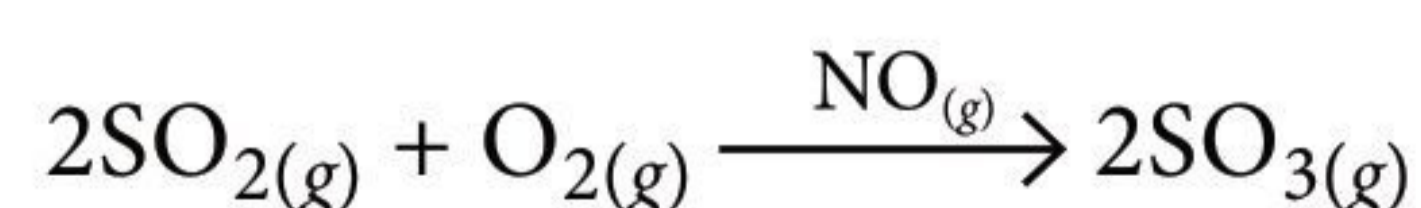


Catalysis is of various types as shown in the below flow chart:



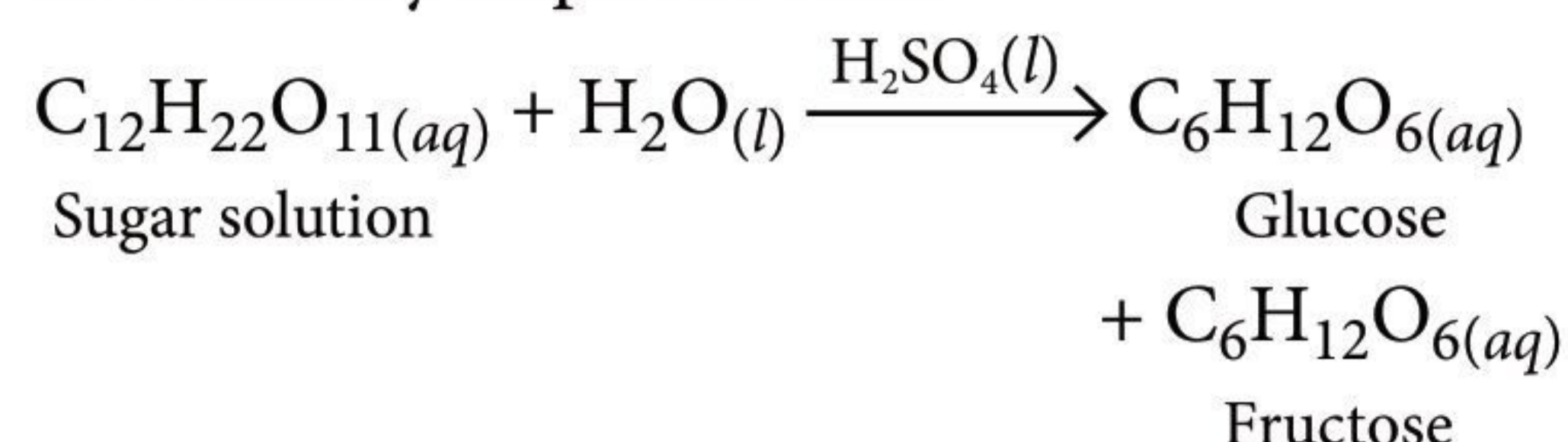
Homogeneous and Heterogeneous Catalysis

- Homogeneous catalysis** is the process in which the reactants and the catalyst are in the **same phase**. The following are some of the examples of homogeneous catalysis :
 - Oxidation of sulphur dioxide into sulphur trioxide with dioxygen in the presence of oxides of nitrogen as the catalyst in the lead chamber process.



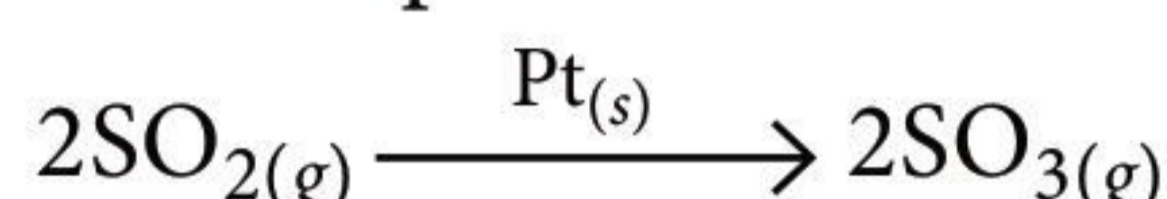
- Hydrolysis of sugar is catalysed by H^+ ion

furnished by sulphuric acid.



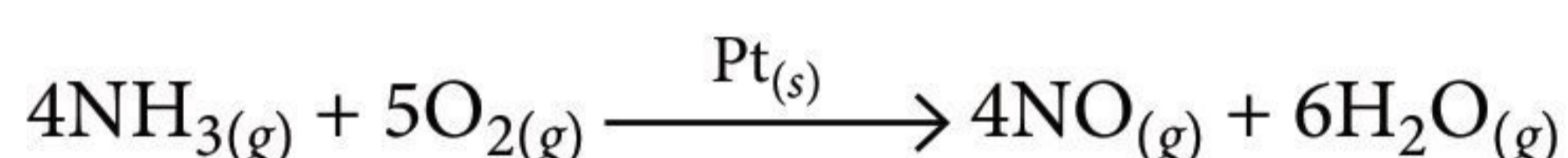
- **Heterogeneous catalysis** is the process in which the reactants and the catalyst are in **different phases**. Some of the examples of heterogeneous catalysis are given as :

- Oxidation of sulphur dioxide into sulphur trioxide in the presence of Pt.



The reactant is in gaseous state while the catalyst is in the solid state.

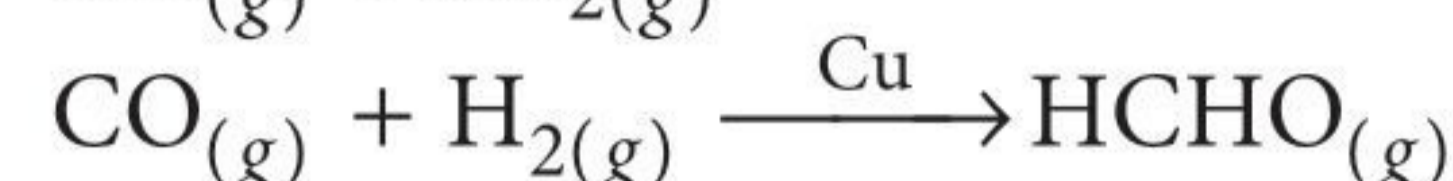
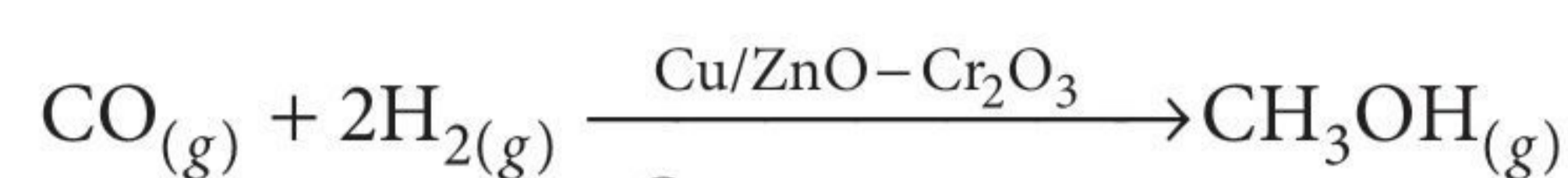
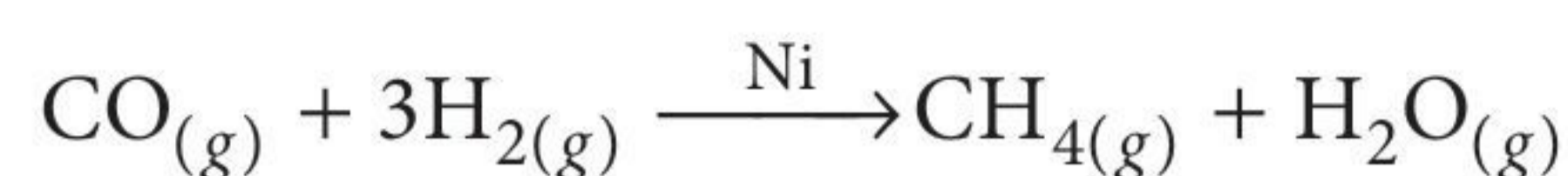
Oxidation of ammonia into nitric oxide in the presence of platinum gauze in Ostwald's process.



Adsorption Theory of Heterogeneous Catalysis

- According to this theory, reaction involves following steps :
 - Diffusion of reactants to the surface of catalyst.
 - Adsorption of reactants molecules on the surface of catalyst.
 - Reactants combine together at the surface to form first an intermediate which finally forms product.
 - Desorption of products takes place from the surface of catalyst.
 - Catalyst is again available for further reaction.
- **Important features of solid catalysts :**
 - **Activity :** The activity of the catalyst is its capacity to increase the speed of the chemical reaction.
 - The ability of a catalyst depends upon strength of chemisorption but, reactants must not get adsorbed so strongly that, they are immobilised and other reactants are left with no space on the catalyst's surface for adsorption.
 - **Selectivity :** The selectivity of a catalyst is its ability to direct a reaction to yield a particular product.
 - Selectivity of different catalysts for same reactants is different. For example, starting with H_2 and CO , and using different catalysts, we get

different products.



- The catalytic reaction that depends upon the pore structure of the catalyst and the size of the reactant and product molecules is called **shape-selective catalysis**. **Zeolites** are good shape-selective catalysts because of their **honeycomb-like structures**.

Enzyme Catalysis

- Enzymes are complex nitrogenous organic compounds which are produced by living plants and animals. They are high molecular mass protein molecules. Enzymes form colloidal solutions in water and are very effective catalysts. They catalyse numerous biochemical reactions. The enzymes are thus, termed as biochemical catalysts and the phenomenon is known as biochemical catalysis.

Some Enzymatic Reactions :

	Enzyme	Source	Enzymatic reaction
1.	Invertase	Yeast	Sucrose → glucose and fructose
2.	Zymase	Yeast	Glucose → ethyl alcohol and carbon dioxide
3.	Diastase	Malt	Starch → maltose
4.	Maltase	Yeast	Maltose → glucose
5.	Urease	Soyabean	Urea → ammonia and carbon dioxide
6.	Pepsin	Stomach	Protein → Peptides

COLLOIDAL STATE

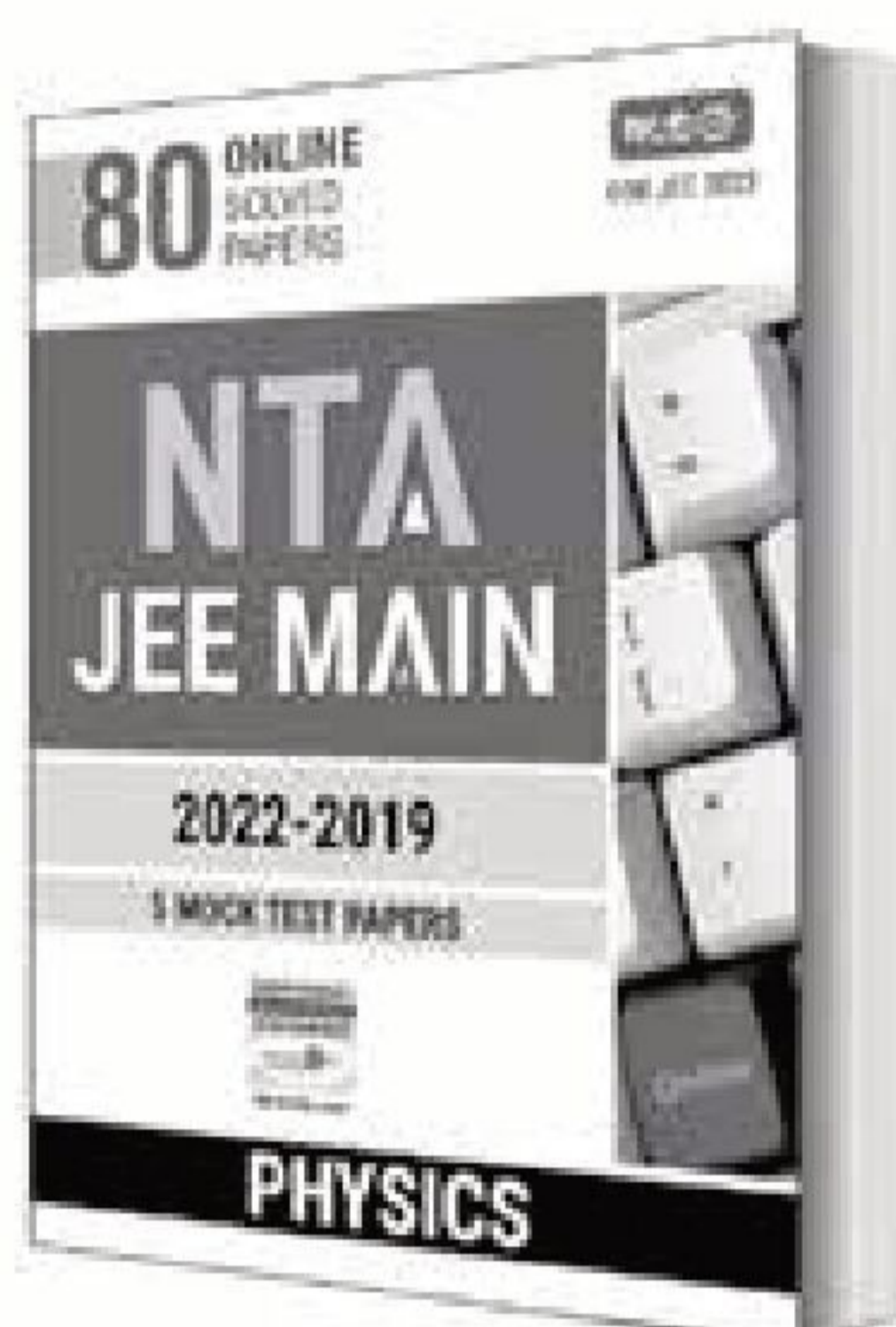
A colloid is a heterogeneous system in which one substance is dispersed (dispersed phase) as very fine particle in another substance called dispersion medium.

Solution and colloids are essentially differentiated on the basis of size. The size of particles of solution are small while particles of colloid vary from range between 1 to 1000 nm.

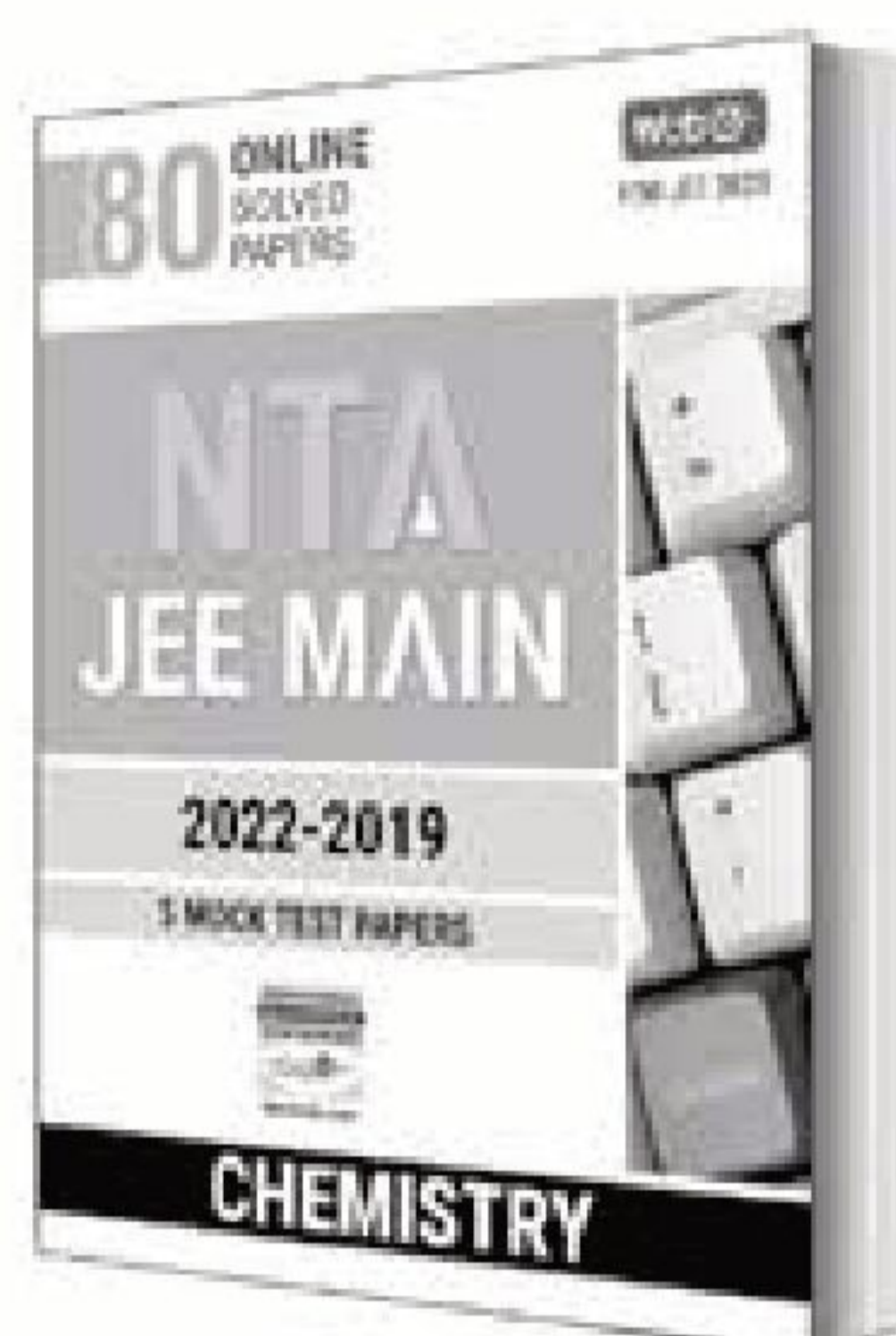
Classification of Colloids

- Depending on the physical states of dispersed phase and dispersion medium :

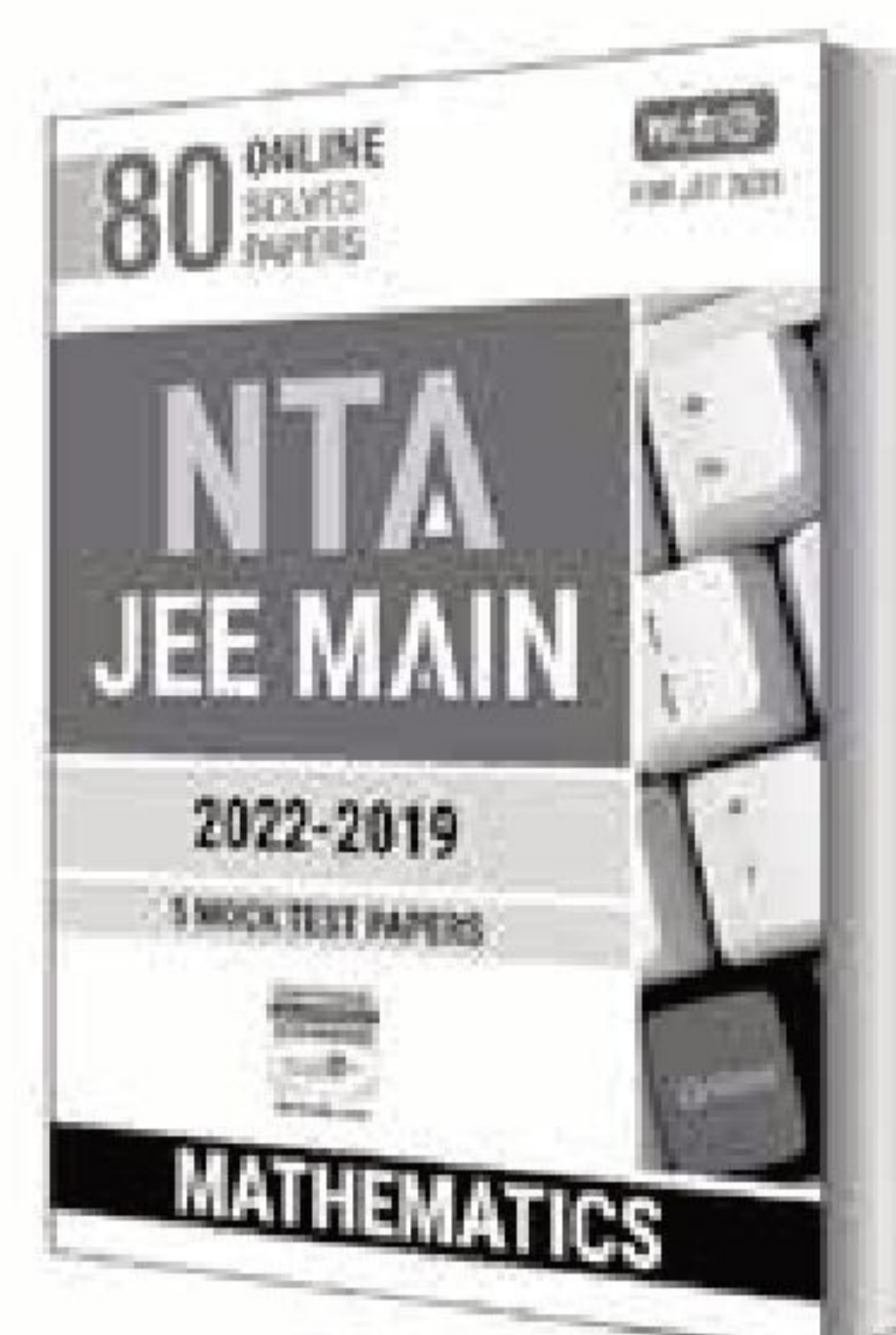
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Dispersed Phase	Dispersion Medium	Name	Common Examples
Gas	Gas	One phase system	Air
	Liquid	Foam	Soap lather, whipped cream
	Solid	Solid sol	Pumice stone, foam rubber
Liquid	Gas	Aerosol	Fog, clouds, mist
	Liquid	Emulsion	Milk, hair cream
	Solid	Gel	Cheese, butter
Solid	Gas	Aerosol	Smoke, volcanic dust
	Liquid	Sol	Paints, cell fluids
	Solid	Solid sol	Some coloured glasses and gemstones

- Depending on the nature of interaction between dispersed phase and dispersion medium :

- Lyophilic colloids
- Lyophobic colloids

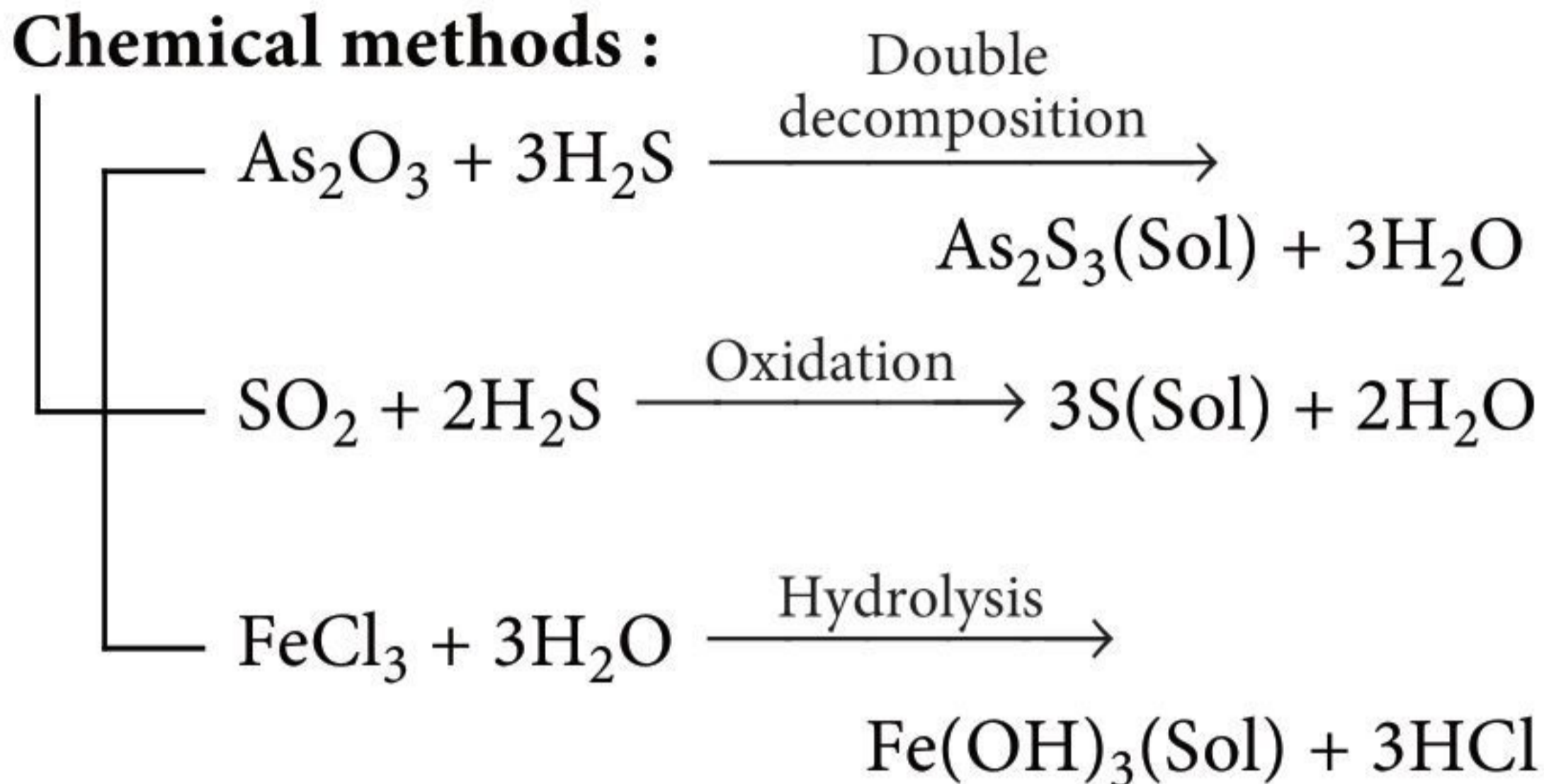
Property	Lyophilic Colloids	Lyophobic Colloids
Interaction	Strong	Weak
Preparation	By mixing substances like gum, gelatine with the suitable liquid (dispersion medium)	By special methods
Reversibility	Reversible	Irreversible
Stability	More stable	Less stable
Viscosity	Higher than medium	Same as medium

- Depending upon the type of particles of dispersed phase:
 - **Multimolecular colloids** : These solutions consist of aggregates of atoms or small molecules with diameter less than 1 nm and the molecules are held together by van der Waals' forces. *e.g.*, gold sols, sulphur (S₈) molecules.
 - **Macromolecular colloids** : In these colloids, the dispersed particles are themselves large molecules (usually polymers). Most lyophilic sols belong to this category.

- **Associated colloids (Micelles)** : Some substances which at low concentration behave as normal strong electrolytes, but at higher concentration exhibit colloidal behaviour due to formation of aggregates. The aggregated particles thus formed are called micelles or associated colloids.

Preparation of Colloids :

Chemical methods :



- **Electrical disintegration or Bredig's Arc method** : Used to prepare colloidal sol of gold, silver, platinum etc.

- **Peptization** : Process of converting precipitate into colloidal sol.

Purification of colloidal solutions :

Methods of purification

- Dialysis
- Electro dialysis
- Ultra filtration

Properties of colloids

- Colligative properties
- Tyndall effect
- Colour
- Brownian movement
- Charge on colloidal particles
- Electrophoresis
- Coagulation or precipitation

- Different electrolytes are known to have different coagulation powers. The coagulation behaviour is governed by **Hardy—Schulze rule** according to which:
 - The effective ion of electrolyte having opposite charge to sol particles causes coagulation.

- Coagulating power of an electrolyte depends on the valency of oppositely charged ion, greater the valency of oppositely charged ions, more is the coagulating power.
- The minimum amount of an electrolyte (millimoles) that must be added to one litre of a colloidal solution so as to bring about complete coagulation is called coagulation or flocculation value of the electrolyte.

$$\text{Flocculation value} \propto \frac{1}{\text{Coagulating power}}$$

EMULSIONS

- Colloids in which both dispersed phase and dispersion medium are in liquid state.
- **Types of emulsions :**
 - **Oil in water (O/W)** where dispersed phase is oil, e.g., milk, vanishing lotion.
 - **Water in oil (W/O)** where dispersed phase is water, e.g., butter cream.
- **Emulsification :** Process of making an emulsion.
 - **Emulsifying agent :** Used to stabilize the emulsion by forming an interfacial film between suspended particles and the medium. e.g., soaps and detergents.

GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

- The process of extraction of metals from their ores is called **metallurgy**.
- Metallic ores are often found to contain certain sand, clay, quartz, feldspar, silicates, mica, etc. These unwanted impurities are called **gangue** or **matrix**.

METALLURGICAL PROCESSES

Metallurgy of a metal involves the following steps :

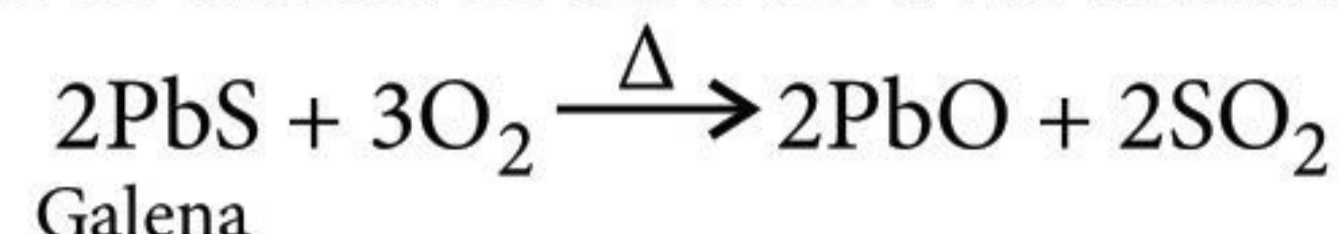
- **Concentration of ore :** Removal of the undesirable foreign impurities. Depending upon the natures of the ore and the impurities present, different methods are used for concentration of ore.
 - **Handpicking :** When impurities present are of large size.
 - **Froth floatation process :** Used for concentration of sulphide ore and based on preferential wetting of ore by oil.
 - **Electromagnetic separation :** When either ore or impurities are magnetic in nature.

- **Leaching process :** Ore is treated with suitable reagent that preferentially dissolves the ore particle while impurities remain insoluble.

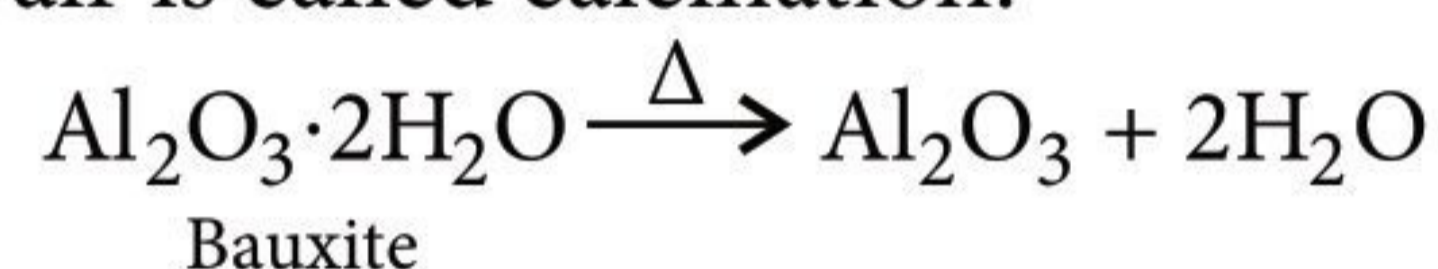
- **Gravity separation :** Used when ore particles are heavier than impurities.

- **Conversion of ore into metal oxide :**

- **Roasting:** In this process, the concentrated ore (usually sulphide) is heated strongly, in the presence of excess of air below its melting point.



- **Calcination :** The process of converting concentrated ore into oxide by, heating it strongly below its melting point in the absence of air is called calcination.



- **Reduction of metal oxide to free metal :** To remove the infusible impurity (gangue) from calcined or roasted ore, **flux** is added during reduction. It combines with earthy impurities to form easily fusible mass called slag. There are :

Acidic flux : Acidic flux like silica (SiO_2) and borax ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$) are used to remove basic earthy impurities (gangue) such as CaO , MgO , FeO , etc.

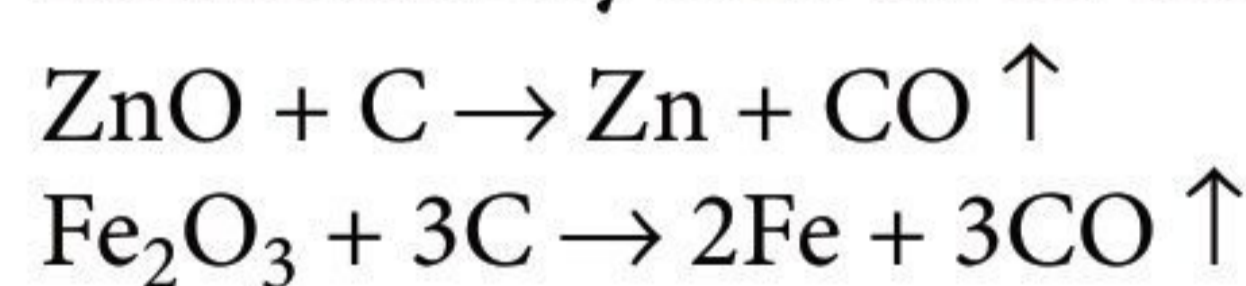


Basic flux : Basic flux like lime (CaO), magnesium oxide (MgO) are used to remove acidic gangue such as SiO_2 , P_4O_{10} , etc.

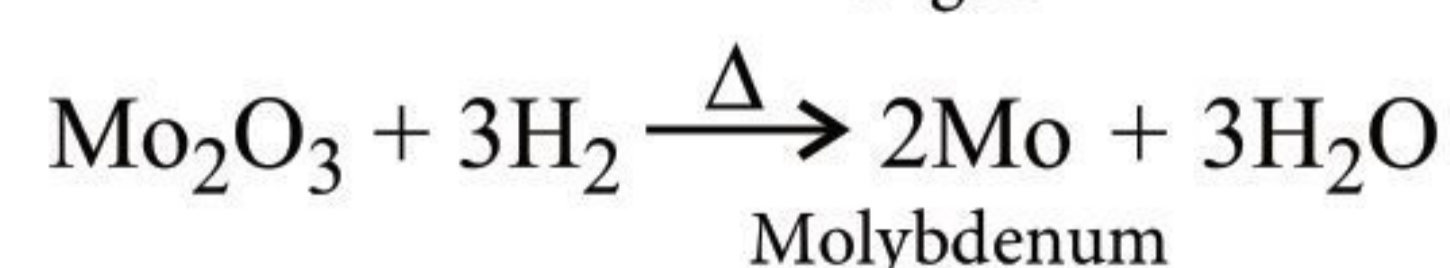
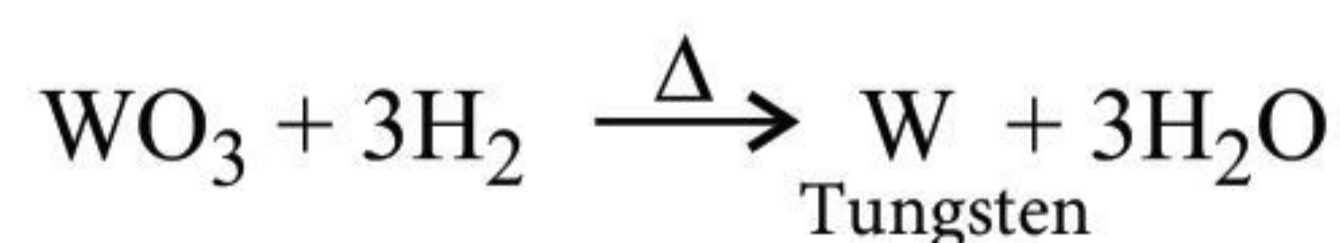
The slag is lighter and insoluble in the molten metal. So it can be easily removed from the surface of the molten metal. Slag is used in manufacture of cement and fertilizers.

Neutral flux : The neutral compound added to decrease the melting point and to make the ore conducting in an electrolytic cell is called neutral flux. For example CaF_2 , cryolite (Na_3AlF_6), KF , etc.

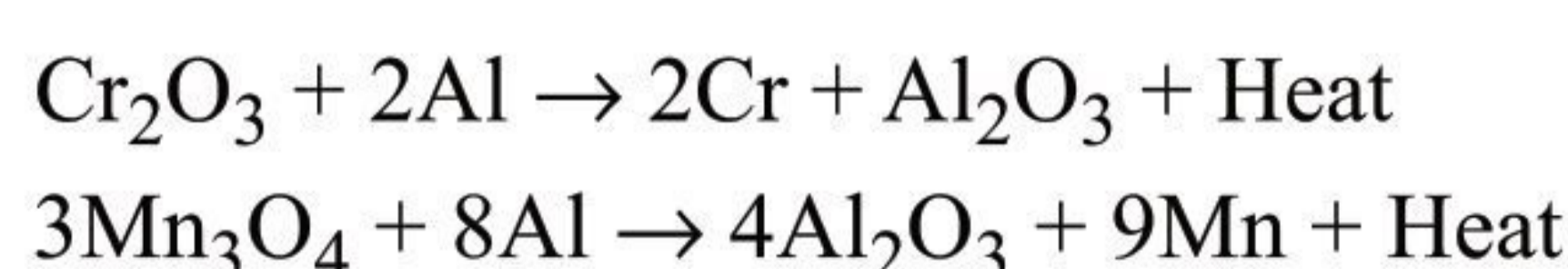
- **Reduction by carbon or smelting :**



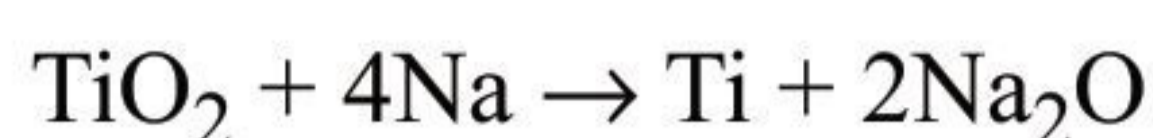
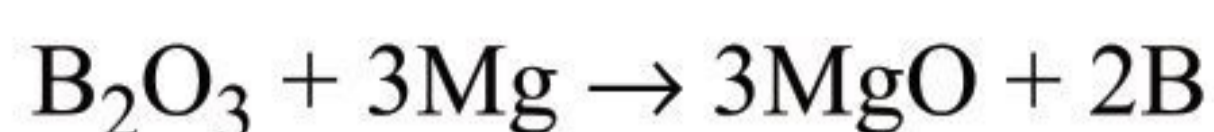
- **Reduction by hydrogen :**



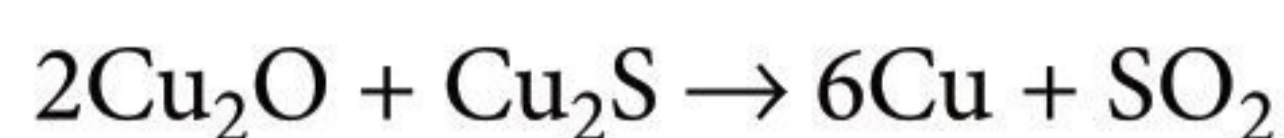
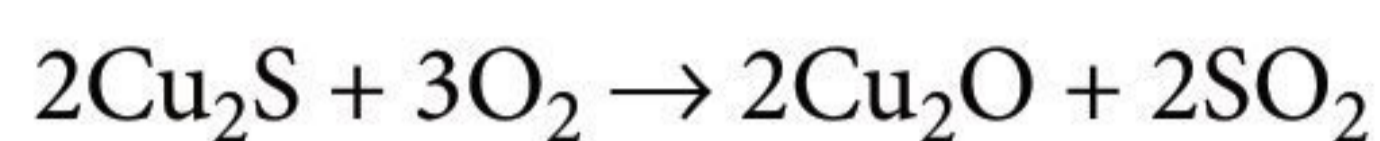
- **Aluminium reduction method :**



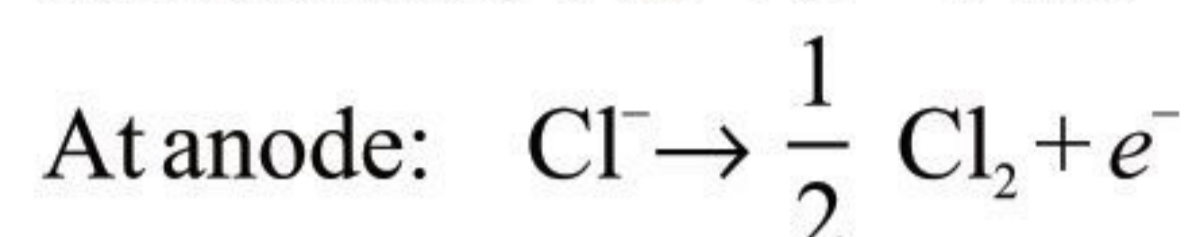
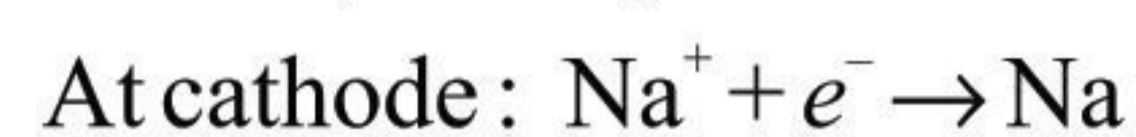
➤ **Reduction by other metals :**



➤ **Self-reduction method :**



➤ **Electrolytic reduction :**



- **Hydrometallurgy :** The process of extraction of a metal from its salt solution is called as **hydrometallurgy**. This process is based on the principle of electrochemical series, that a more electropositive metal displaces a less electropositive metal from its salt solution.

THERMODYNAMICS OF METAL EXTRACTION

Metals in the combined state (ore form) are stable. When a metal goes through various metallurgical process, it becomes thermodynamically less stable due to high energy content. That's why metals in pure form are very reactive and highly susceptible for action of air and water.

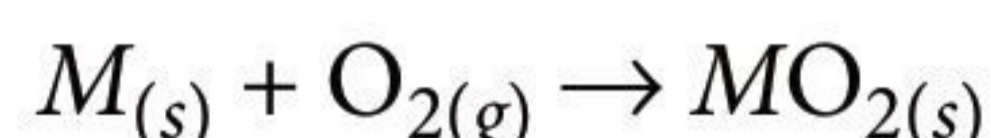
- **Thermodynamics of metal to metal oxides :**

For any spontaneous reaction, change in free energy, ΔG must be negative :

$$\Delta G = \Delta H - T\Delta S$$

where, ΔH is enthalpy change during reaction,

T is temperature and ΔS is change in entropy during reaction.



During the formation of a metal oxide, a solid (metal oxide) is formed from gas (O_2) *i.e.* entropy is decreasing. Hence, ΔS is negative. Now if temperature is increased $T\Delta S$ will be more negative which results in less negative value of ΔG . Thus free energy change increases (not favourable) with increase in temperature.

A graphical representation of variation of ΔG with increase in temperature for oxides of metals is known as **Ellingham diagram**.

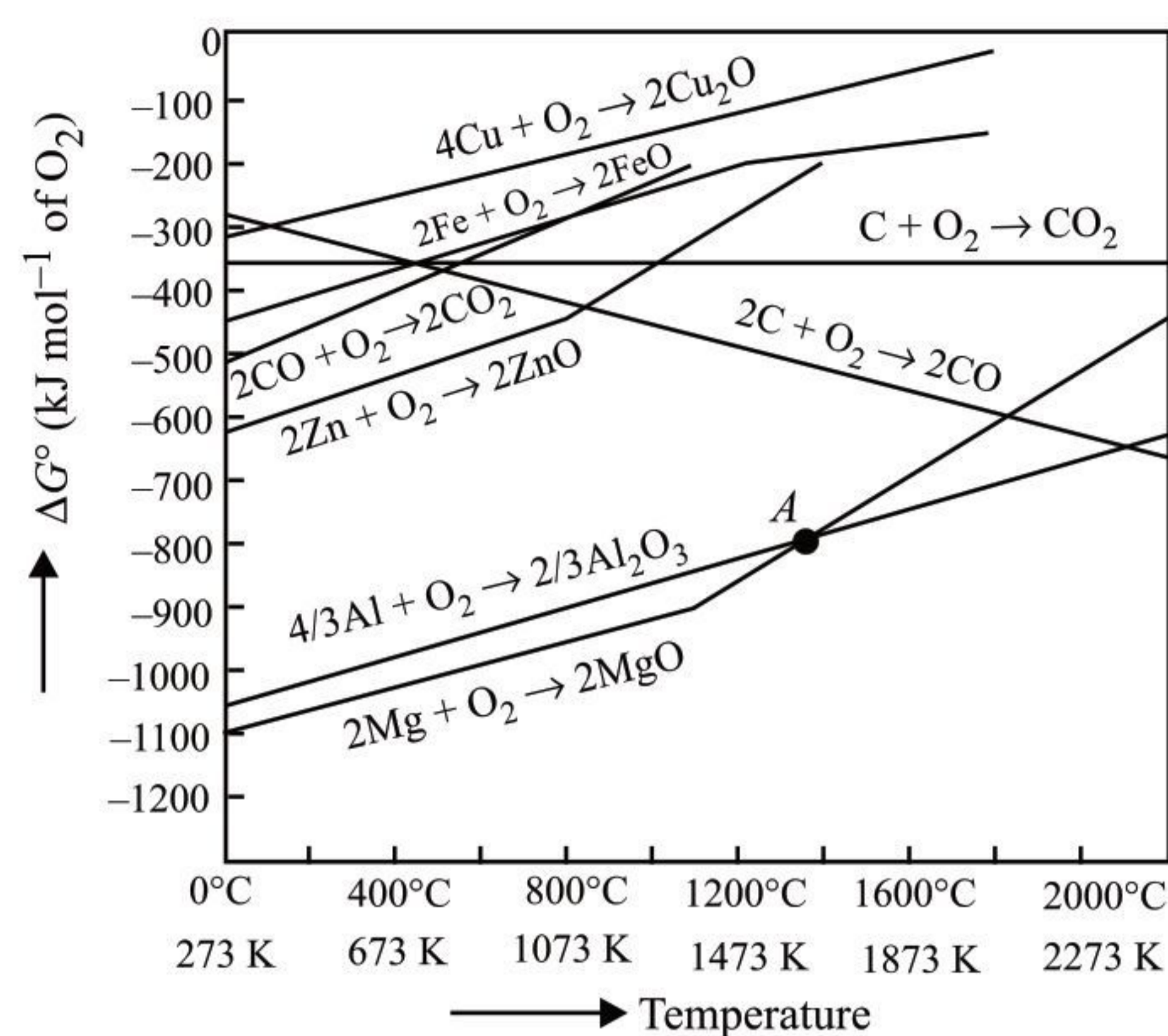
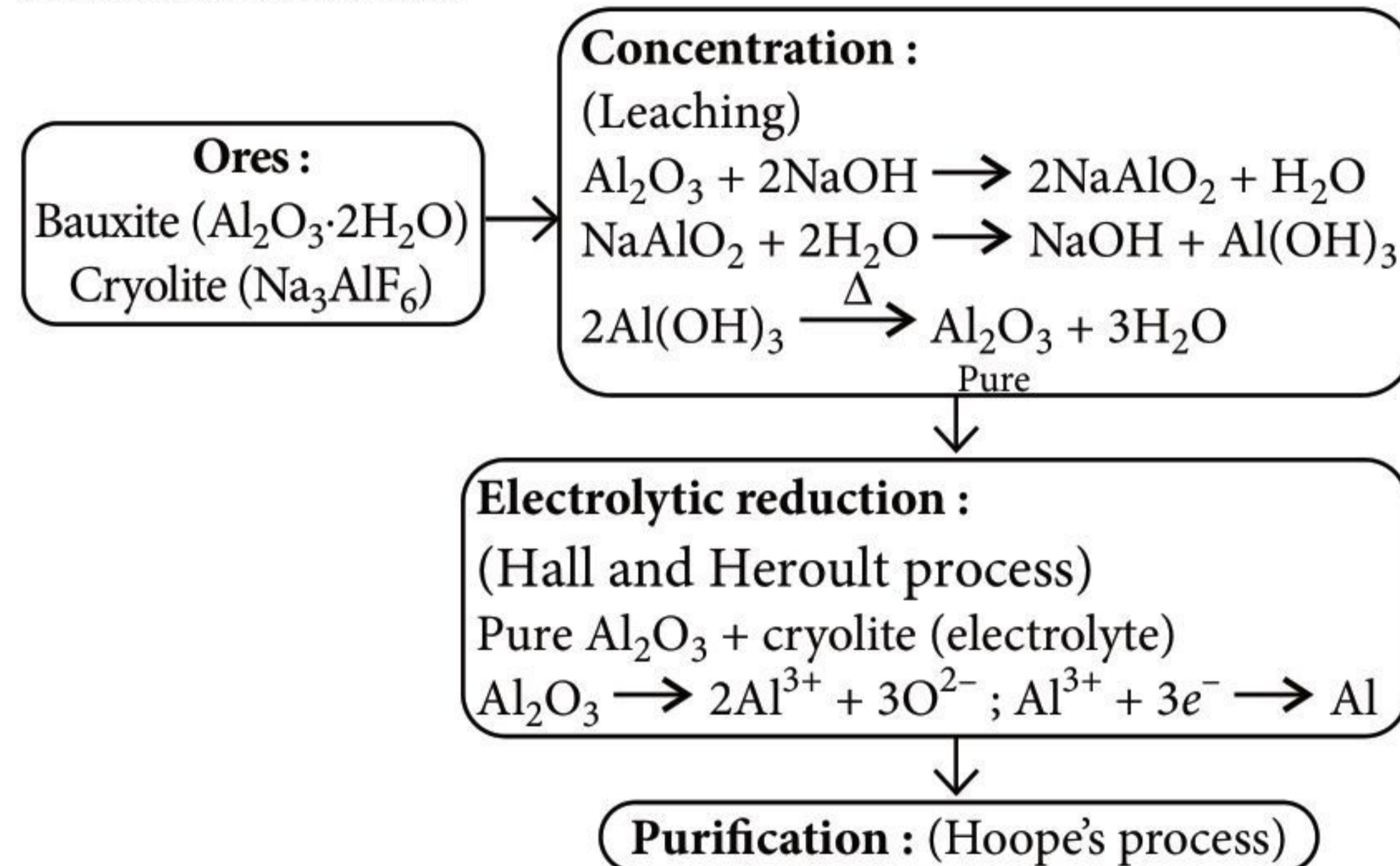


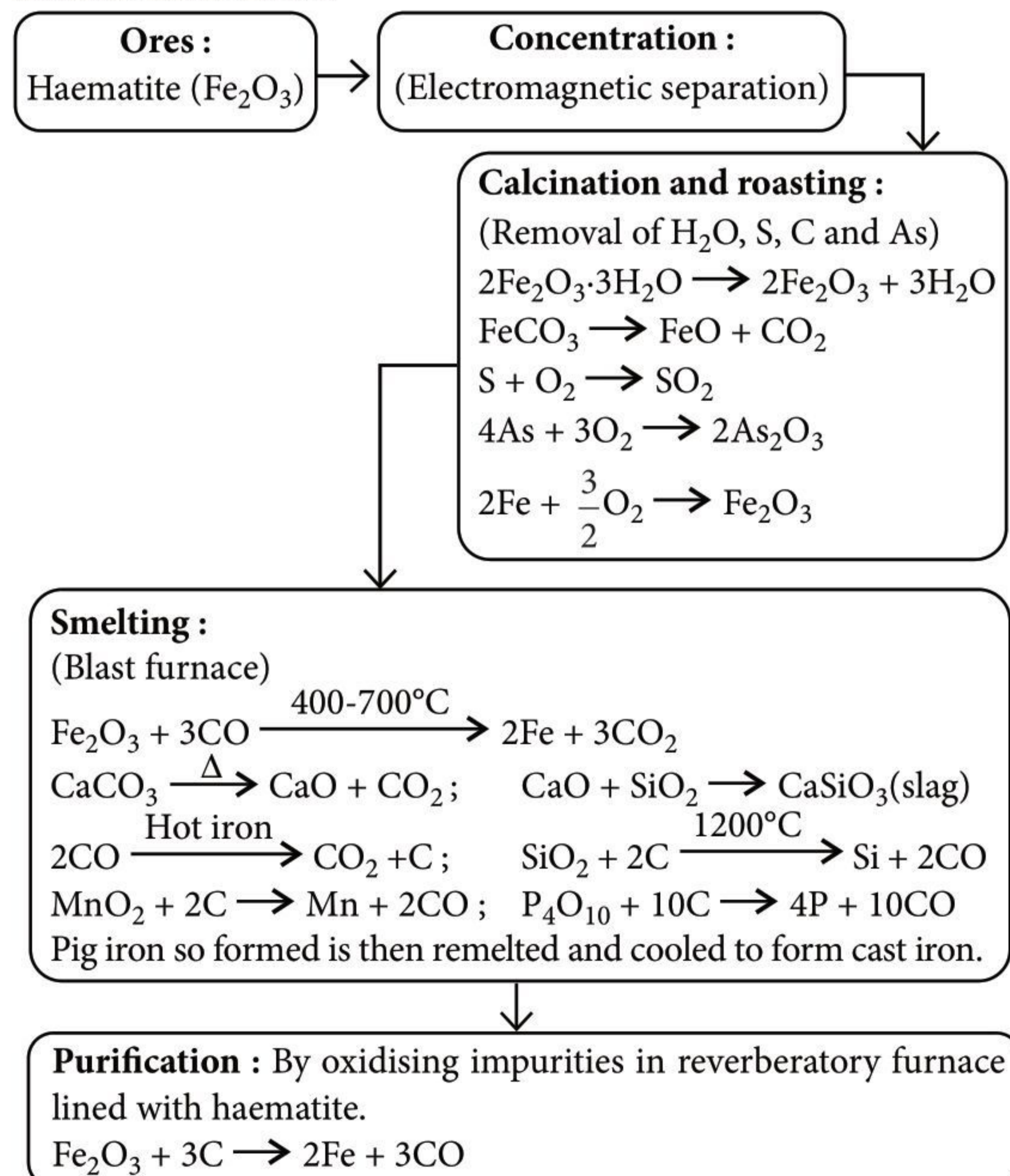
Fig.: Gibbs energy (ΔG°) vs. T plots (schematic) for formation of some oxides (Ellingham diagram)

Extraction of Some Important Elements

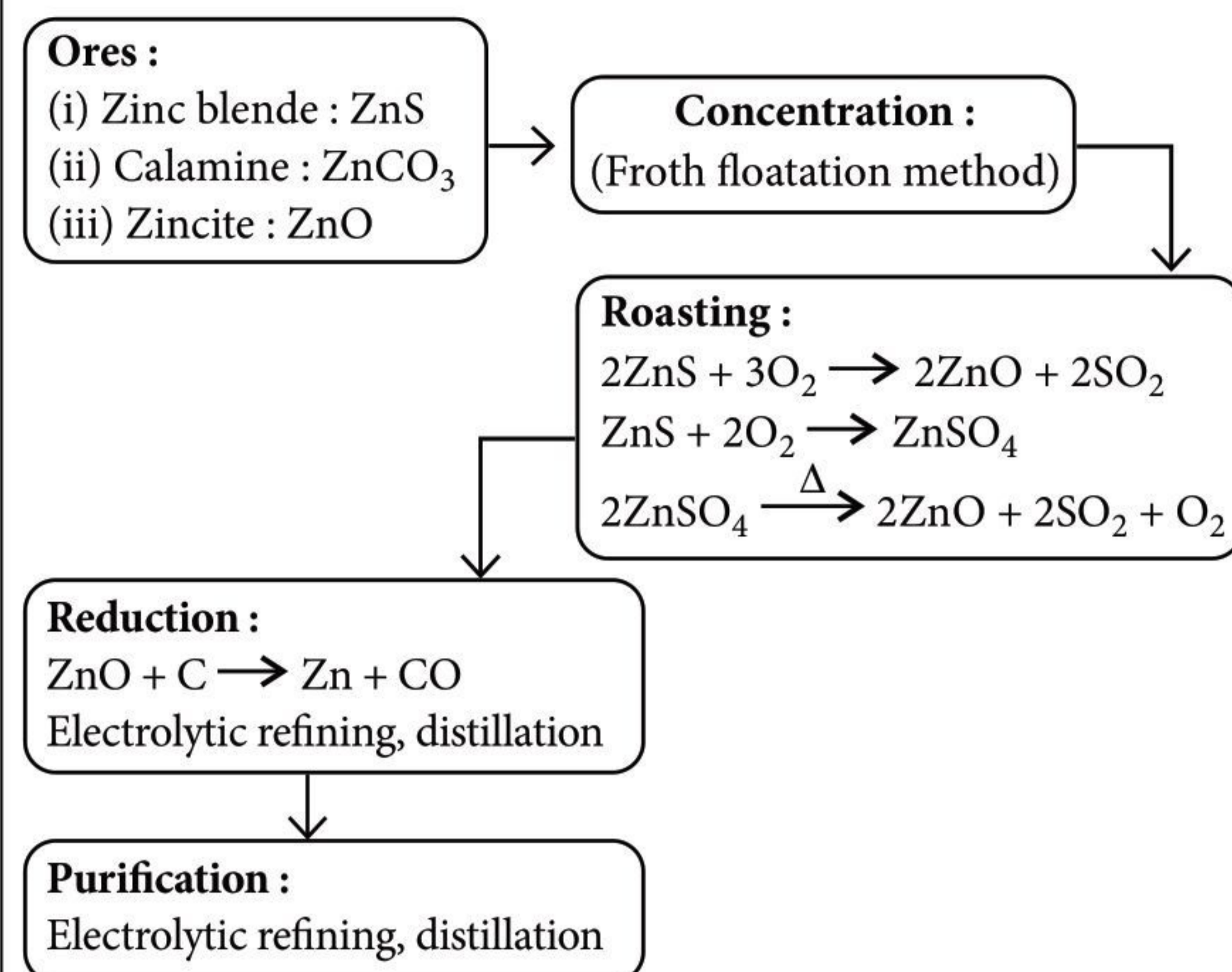
Extraction of Al



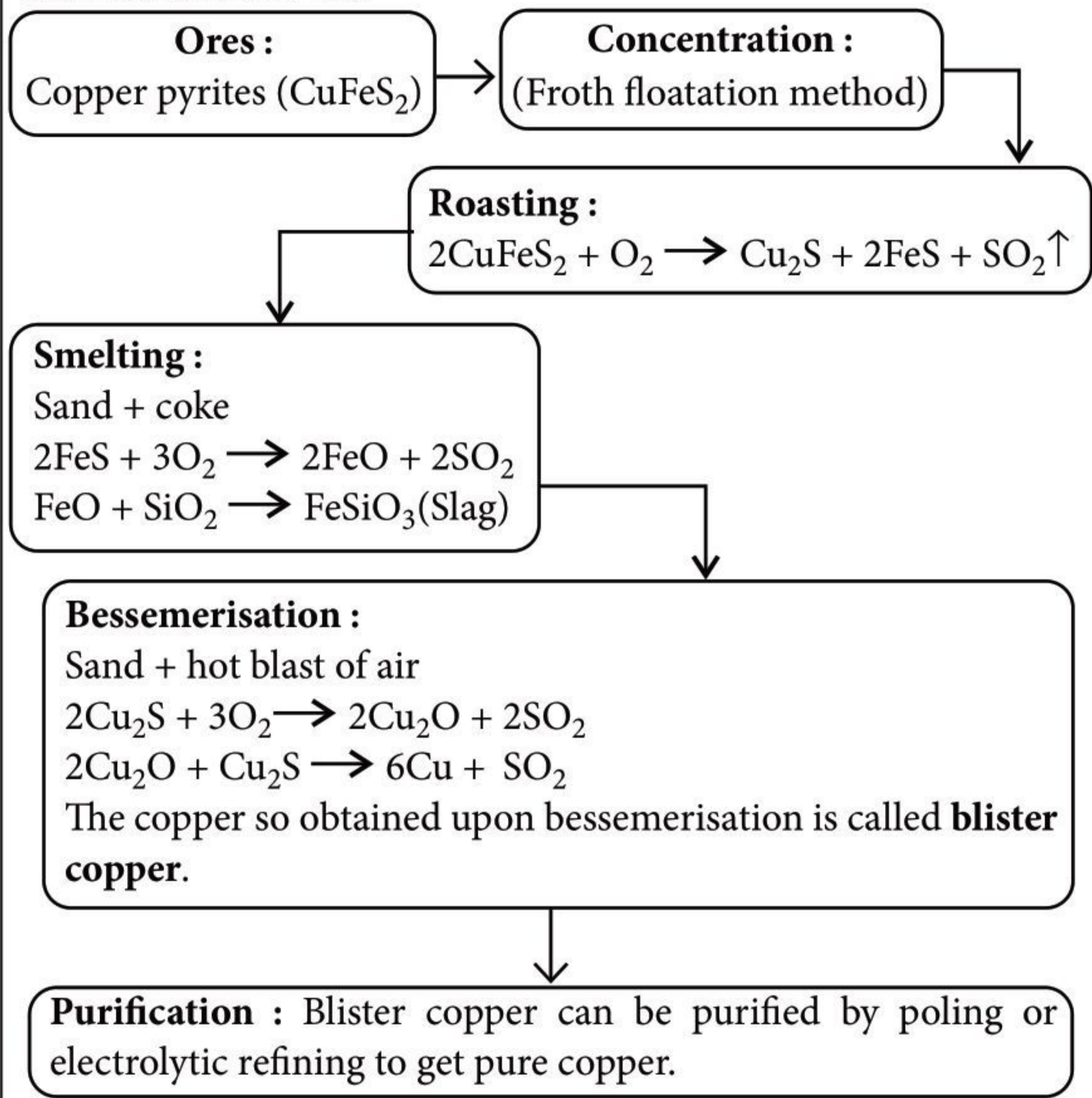
Extraction of Fe



Extraction of Zn



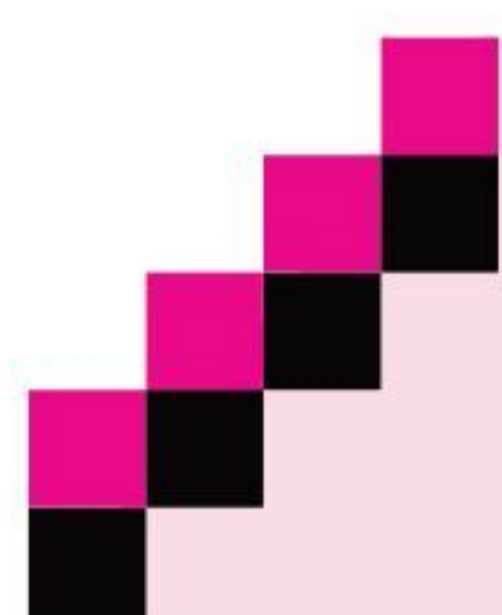
Extraction of Cu



REFINING OF METALS

Purification of crude metal is called **refining**.

Methods	Metals Purified
Liquation	Used for low melting metals like Sn, Pb, Hg, Bi, etc.
Distillation	Used for volatile metals like Zn, Hg, Cd, etc., or metals containing non-volatile impurities.
Poling	Used for metals which contain impurities of their own oxides e.g., Cu.
Cupellation	Used for metals containing easily oxidisable impurities e.g., Ag containing Pb impurities.
Electrolytic refining	Used for metals like Cu, Ag, Au, Al which get deposited at cathode and impurities get deposited at anode. Solution of a soluble metal salt acts as the electrolyte.
Mond's process	Used for refining of Ni. $4\text{CO} + \text{Ni} \xrightarrow{60^\circ-80^\circ\text{C}} \text{Ni}(\text{CO})_4$ <div style="display: flex; justify-content: space-around; align-items: center;"> Impure Pure </div> $\text{Ni} + 4\text{CO} \xleftarrow{180^\circ\text{C}}$
Zone refining	Used to produce extremely pure metals (semiconductors) like Si, Ge, Ga, B and In.
van Arkel method	Used for ultra-pure metals like Ti, Zr which are used in space technology. $\text{Ti}_{(s)} + 2\text{I}_{2(g)} \xrightarrow{523\text{ K}} \text{TiI}_{4(g)} \xrightarrow{1673\text{ K}} \text{Ti}_{(s)} + 2\text{I}_{2(g)}$ <div style="display: flex; justify-content: space-around; align-items: center;"> Impure Pure </div> $\text{Zr} + 2\text{I}_2 \xrightarrow{870\text{ K}} \text{ZrI}_4 \xrightarrow{1800\text{ K}} \text{Zr}_{(s)} + 2\text{I}_{2(g)}$ <div style="display: flex; justify-content: space-around; align-items: center;"> Impure Pure </div>



WRAP it up!

MCQs TYPE QUESTIONS

- Which one is malachite from the following?
 (a) $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ (b) CuFeS_2
 (c) $\text{Cu}(\text{OH})_2$ (d) Fe_3O_4
- A homogeneous catalytic process among the following is
 (a) Haber's process of manufacturing ammonia
 (b) contact process of manufacturing sulphuric acid
 (c) Ostwald's process of manufacturing nitric acid
 (d) lead chamber process of manufacturing sulphuric acid.
- Which of the following is an ore of zinc?
 (a) Galena (b) Pyrolusite
 (c) Sphalerite (d) Magnetite

4. Which of the following is not correct?
 (a) Chemical adsorption is reversible in nature.
 (b) Physical adsorption is reversible in nature.
 (c) ΔH is small in physical adsorption.
 (d) ΔH is large in chemical adsorption.
5. Gold number indicates
 (a) protective action of lyophilic colloid
 (b) charge on gold sol
 (c) protective action of lyophobic colloid
 (d) quantity of gold dissolved in a given sol.
6. The dispersed phase and dispersion medium of fog respectively are
 (a) solid and liquid (b) liquid and liquid
 (c) liquid and gas (d) gas and liquid.
7. Which of the statements is true regarding chemisorption of a gas on a solid surface?
 (a) This type of adsorption first increases with increase of temperature.
 (b) No compound formation takes place in this case.
 (c) The forces operating in this are weak van der Waals' forces.
 (d) It forms multimolecular layers of gas molecules on the surface.
8. What is the role of aniline or cresol when added in a froth floatation process?
 (a) Stabilizer (b) Depressant
 (c) Wetting agent (d) All of these.
9. Sulphur sol is an example of
 (a) macromolecular colloid
 (b) associated colloid
 (c) multimolecular colloid
 (d) hydrophilic colloid.
10. Milk is an example of
 (a) emulsion (b) sol
 (c) gel (d) foam.
11. The extraction of which of the following metals involves bessemerisation?
 (a) Fe (b) Ag (c) Al (d) Cu
12. Baeyer's method is used for
 (a) purification of the metal
 (b) smelting
 (c) concentration of the ore
 (d) purification of the ore.
13. Native silver metal forms a water soluble complex with a dilute aqueous solution of NaCN in the presence of
 (a) nitrogen (b) oxygen
 (c) carbon dioxide (d) argon.

14. **Assertion** : Magnesium is extracted by the electrolysis of fused mixture of MgCl_2 , NaCl and CaCl_2 .

Reason : Calcium chloride acts as a reducing agent.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) Assertion is true but reason is false.
 (d) Both assertion and reason are false.

15. **Assertion** : $\text{Fe}(\text{OH})_3$ and As_2S_3 colloidal sols on mixing precipitate.

Reason : $\text{Fe}(\text{OH})_3$ and As_2S_3 combine and form precipitate of new composition.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) Assertion is true but reason is false.
 (d) Both assertion and reason are false.

16. In the metallurgy of iron, when limestone is added as flux to the blast furnace, the calcium ion ends up in

- (a) slag (b) gangue
 (c) metallic calcium (d) calcium carbonate.

17. Match the column I and column II and mark the appropriate choice.

	Column I		Column II
(A)	Diastase	(i)	Proteins \rightarrow Peptide
(B)	Pepsin	(ii)	Glucose \rightarrow ethyl alcohol
(C)	Ptyalin	(iii)	Starch \rightarrow maltose
(D)	Zymase	(iv)	Starch \rightarrow sugar

- (a) (A) \rightarrow (iv), (B) \rightarrow (ii), (C) \rightarrow (i), (D) \rightarrow (iii)
 (b) (A) \rightarrow (ii), (B) \rightarrow (i), (C) \rightarrow (iv), (D) \rightarrow (iii)
 (c) (A) \rightarrow (i), (B) \rightarrow (ii), (C) \rightarrow (iii), (D) \rightarrow (iv)
 (d) (A) \rightarrow (iii), (B) \rightarrow (i), (C) \rightarrow (iv), (D) \rightarrow (ii)

18. Match the column I with column II and mark the appropriate choice.

	Column I		Column II
(A)	Calamine	(i)	Calcium
(B)	Barytes	(ii)	Barium
(C)	Cinnabar	(iii)	Zinc
(D)	Limestone	(iv)	Mercury

- (a) (A) → (iv), (B) → (iii), (C) → (i), (D) → (ii)
 (b) (A) → (iii), (B) → (ii), (C) → (iv), (D) → (i)
 (c) (A) → (i), (B) → (iv), (C) → (ii), (D) → (iii)
 (d) (A) → (ii), (B) → (i), (C) → (iii), (D) → (iv)

19. Which of the following metals is obtained by leaching its ore with dilute cyanide solution?
 (a) Silver (b) Titanium
 (c) Vanadium (d) Zinc
20. Aluminium is obtained by
 (a) reducing Al_2O_3 with coke
 (b) electrolysis of Al_2O_3 dissolved in Na_3AlF_6
 (c) reducing Al_2O_3 with chromium
 (d) heating alumina with cryolite.

NUMERICAL VALUE TYPE QUESTIONS

21. CO_2 gas adsorbs on charcoal following Freundlich adsorption isotherm. For a given amount of charcoal, the mass of CO_2 adsorbed becomes 64 times when the pressure of CO_2 is doubled. The value of n in the Freundlich isotherm equation is $\text{_____} \times 10^{-2}$. (Round off to the nearest integer)
22. 100 mL of 0.0018% (w/v) solution of Cl^- ion was the minimum concentration of Cl^- required to precipitate a negative sol in one hour. The coagulating value of Cl^- ion is _____. (Nearest integer)
23. 50 mL of 1 M oxalic acid is shaken with 0.5 g wood charcoal. The final concentration of the solution after adsorption is 0.5 M. Amount of oxalic acid absorbed per g of charcoal is _____.
24. In the electrolytic refining of blister copper, the total number of main impurities, from the following, Pb, Sb, Se, Te, Ru, Ag, Au and Pt removed as anode mud is _____.
25. Among the following ores Bauxite, Siderite, Cuprite, Calamine, Haematite, Kaolinite, Malachite, Magnetite, Sphalerite, Limonite, Cryolite, the number of principal ores of iron is _____.

SOLUTIONS

1. (a) 2. (d)
 3. (c) : Galena = PbS ; Sphalerite (Zinc blende) = ZnS
 Pyrolusite = MnO_2 ; Magnetite = Fe_3O_4
 4. (a) 5. (a)
 6. (c) : In fog, dispersed phase is liquid and dispersion medium is gas.
 7. (a) 8. (a)
 9. (c) : Sulphur sol consists of particles containing a thousand or more of S_8 sulphur molecules.

10. (a)

11. (d) : Extraction of Cu involves bessemerisation.

12. (d) : Baeyer's process is used for purification of Al_2O_3 ore.

13. (b)

14. (c) : NaCl and CaCl_2 are added to provide conductivity to the electrolyte and also to lower the fusion temperature of anhydrous MgCl_2 .

15. (c) : On mixing $\text{Fe}(\text{OH})_3$ (+ve sol) and As_2S_3 (-ve sol), mutual coagulation occurs which causes precipitation. No new compound is formed.

16. (a)

17. (d)

18. (b) : Calamine - ZnCO_3 ; Barytes - BaSO_4
 Cinnabar - HgS ; Limestone - CaCO_3

19. (a)

20. (b) : Al is obtained by electrolysis of a mixture of fused purified alumina and cryolite. This is called electrolytic reduction. This process of obtaining aluminium by electrolysis of a mixture of purified alumina and cryolite is called Hall and Heroult process.

$$21. (17) : \frac{x}{m} = k(p)^{1/n} \quad \dots(i)$$

$$64 \left(\frac{x}{m} \right) = k(2p)^{1/n} \quad \dots(ii)$$

Dividing (ii) by (i)

$$64 = (2)^{1/n} \Rightarrow \frac{1}{n} = 6$$

$$n = \frac{1}{6} = 0.167 \text{ or } 16.7 \times 10^{-2} \approx 17 \times 10^{-2}$$

22. (1) : Coagulation value : The minimum concentration of electrolyte in millimoles required to cause coagulation of 1 L of colloidal solution.
 Given : 0.0018 gram Cl^- present in 100 mL solution.

$$\text{Coagulation value of } \text{Cl}^- = \frac{\frac{0.0018}{35.5} \times 10^3}{0.1} = 0.507 \approx 1$$

23. (6.3) : Molecular weight of oxalic acid

$$(\text{C}_2\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}) = 126 \text{ g mol}^{-1}$$

$$W = \frac{126 \times 1 \times 50}{1000} = 6.3 \text{ g}$$

0.5 wood charcoal absorbs = 3.15 g

$$1 \text{ g of wood charcoal will absorb} = \frac{3.15}{0.5} = 6.3 \text{ g}$$

24. (6) : The main impurities in blister copper are anti-mony, selenium, tellurium, silver, gold and platinum.

25. (4)





Based on CBSE Circular released on 16th Sept. 2022

CBSE warm-up!

CLASS-XII

Chapterwise practice questions for CBSE Exams as per the latest pattern and reduced syllabus by CBSE for the academic session 2022-23.

Series-6

Haloalkanes and Haloarenes

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

General Instructions : Read the following instructions carefully.

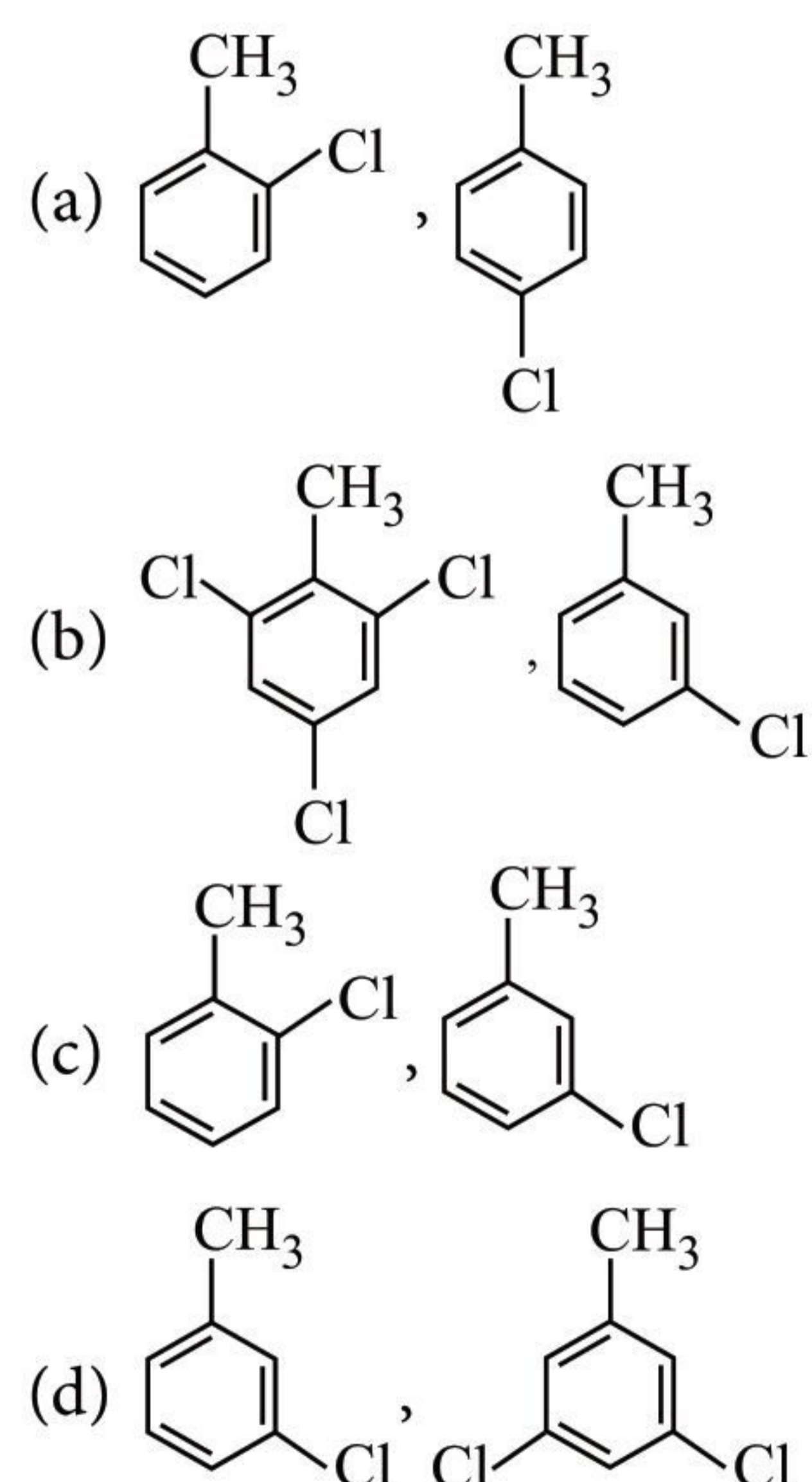
- There are 35 questions in this question paper with internal choice.
- SECTION A consists of 18 multiple-choice questions carrying 1 mark each.
- SECTION B consists of 7 very short answer questions carrying 2 marks each.
- SECTION C consists of 5 short answer questions carrying 3 marks each.
- SECTION D consists of 2 case-based questions carrying 4 marks each.
- SECTION E consists of 3 long answer questions carrying 5 marks each.
- All questions are compulsory.
- Use of log tables and calculators is not allowed.

SECTION A

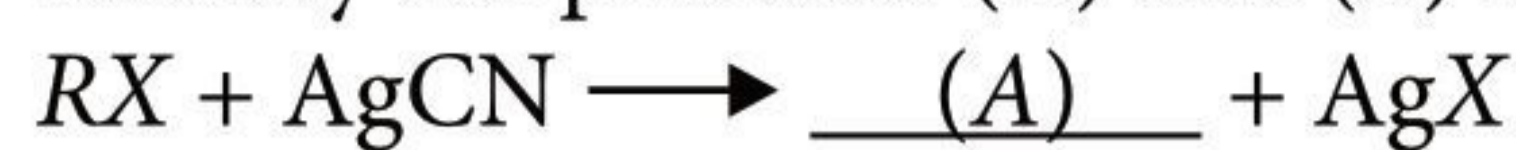
The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

- Arrange the following compounds in order of their reactivity towards S_N2 reaction.
 - $\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{Br}$
 - $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{Br}$
 - $\text{CH}_3\text{CH}_2-\overset{\text{CH}_3}{\underset{|}{\text{CH}}}-\text{CH}_2\text{Br}$
 - $\text{CH}_3-\overset{\text{CH}_3}{\underset{\text{CH}_3}{|}{\text{C}}}-\text{CH}_2\text{Br}$
 - (i) > (ii) > (iii) > (iv)
 - (ii) > (iii) > (iv) > (i)
 - (iii) > (i) > (ii) > (iv)
 - (iv) > (ii) > (i) > (iii)
- A compound X with molecular formula, C_7H_8 is treated with Cl_2 in presence of FeCl_3 . Which of

the following compounds are formed during the reaction?

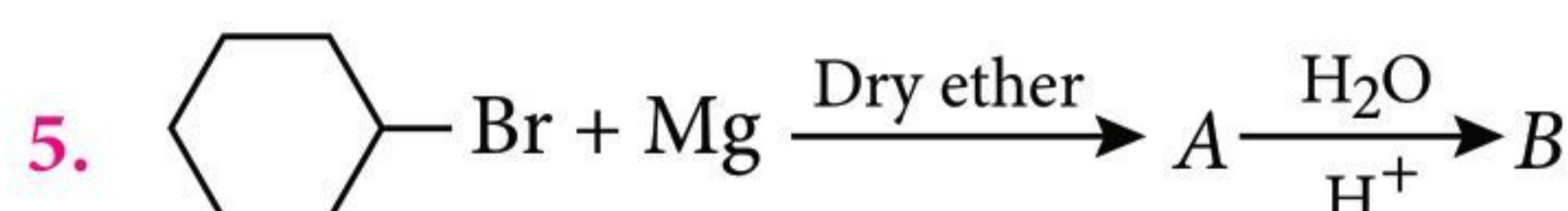
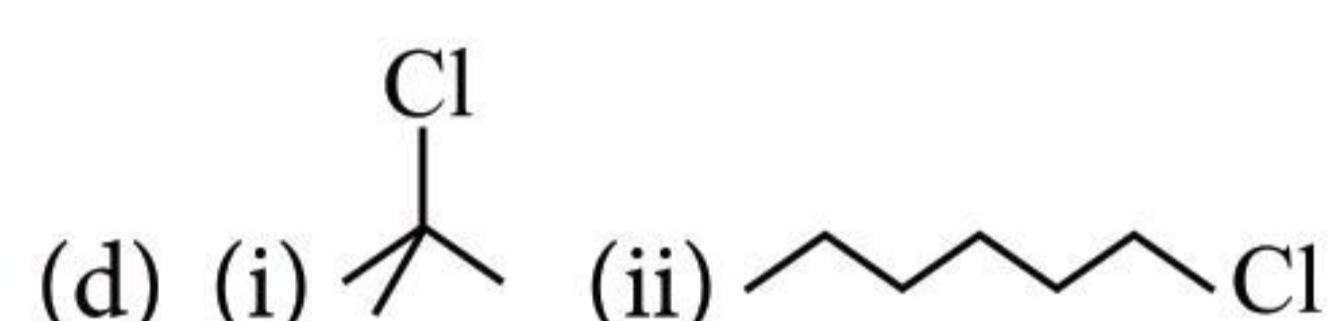
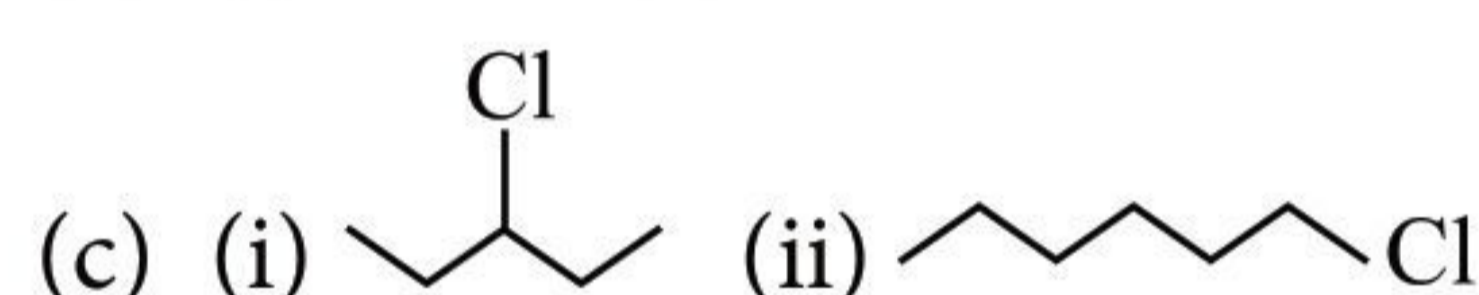
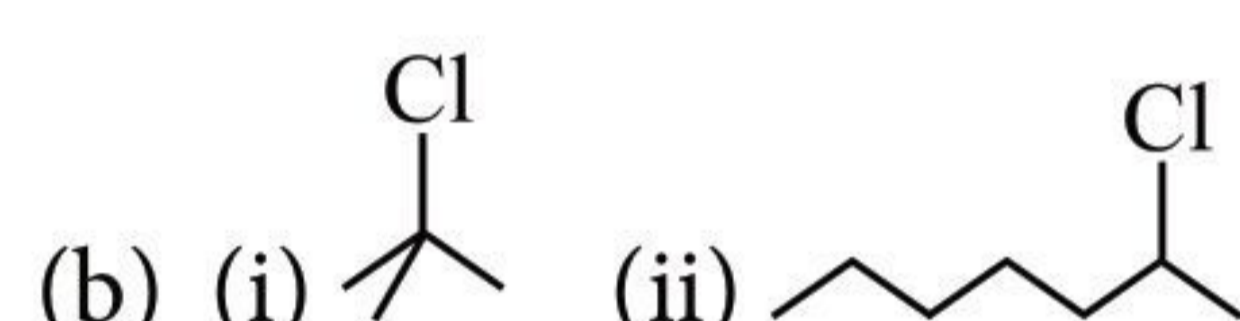
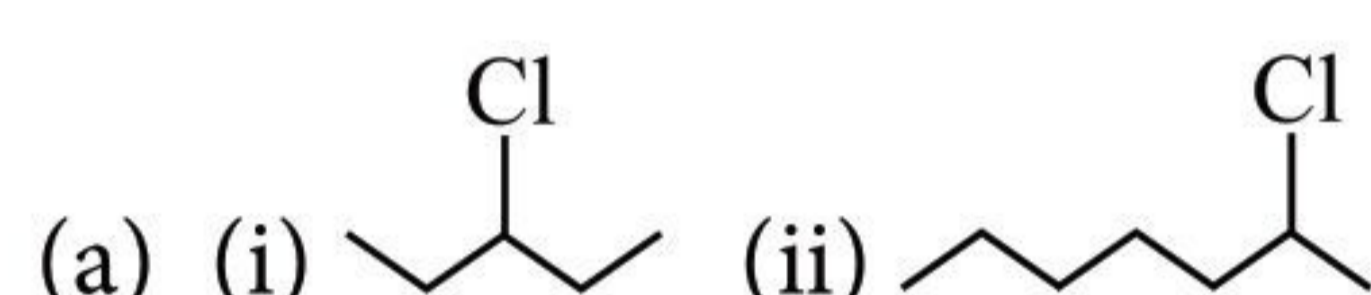
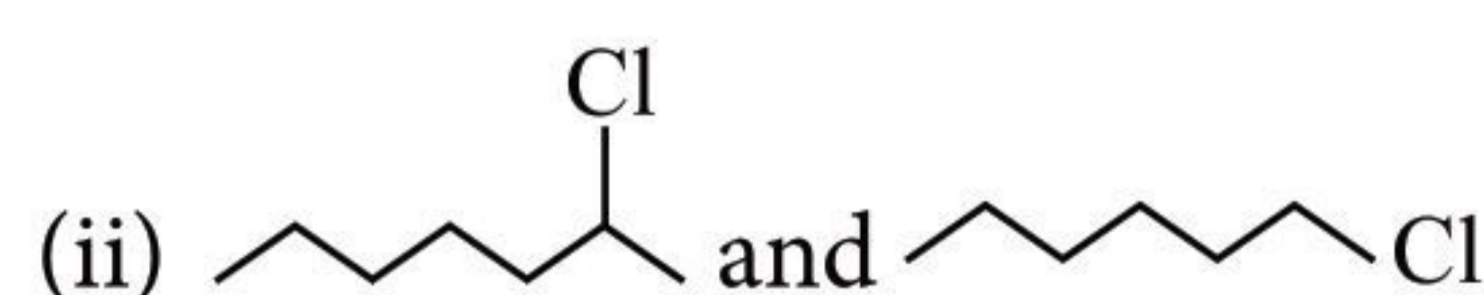
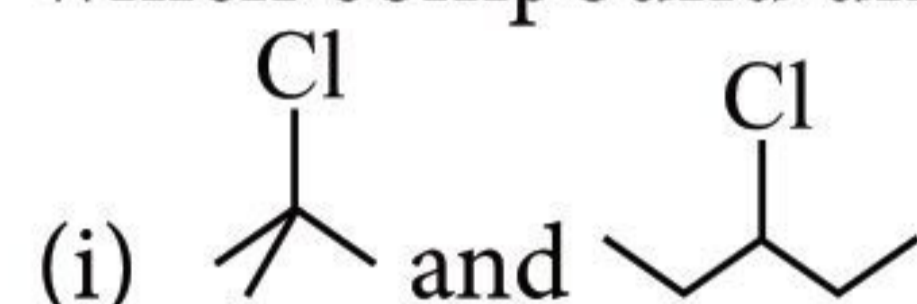


3. Identify the products (A) and (B) in the reactions.

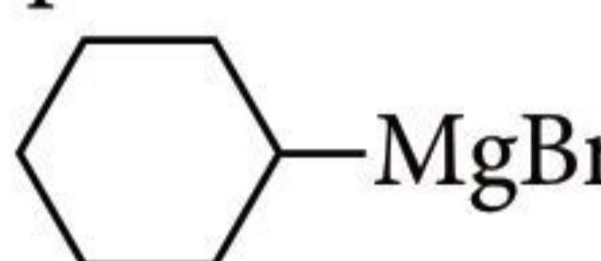
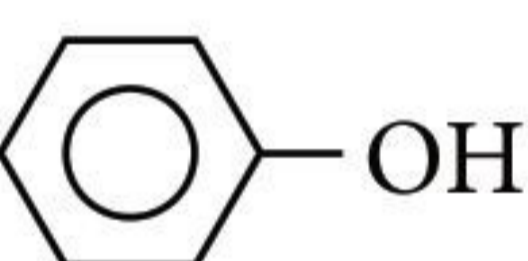
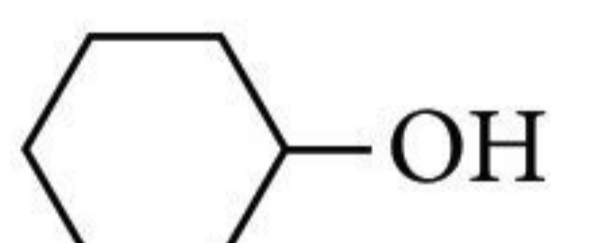
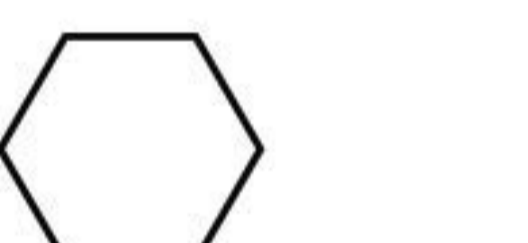


- (a) (A) - RCN, (B) - RCN
 (b) (A) - RCN, (B) - RNC
 (c) (A) - RNC, (B) - RCN
 (d) (A) - RNC, (B) - RNC

4. In the following pairs of halogen compounds, which compound undergoes faster S_N1 reaction?



The product 'B' is

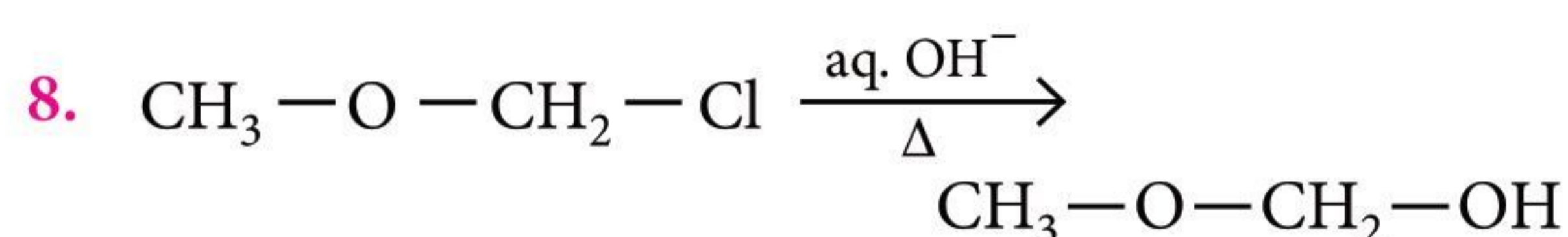
- (a)  (b) 
 (c)  (d) 

6. An incorrect statement with respect to S_N1 and S_N2 mechanisms for alkyl halide is

- (a) a strong nucleophile in an aprotic solvent increases the rate or favours S_N2 reaction
 (b) competing reaction for an S_N2 reaction is rearrangement
 (c) S_N1 reactions can be catalysed by some Lewis acids
 (d) a weak nucleophile and a protic solvent increases the rate or favours S_N1 reaction.

7. Which of the following is the correct IUPAC name for $\text{CH}_3-\text{CH}(\text{C}_2\text{H}_5)-\text{CH}_2-\text{Br}$?

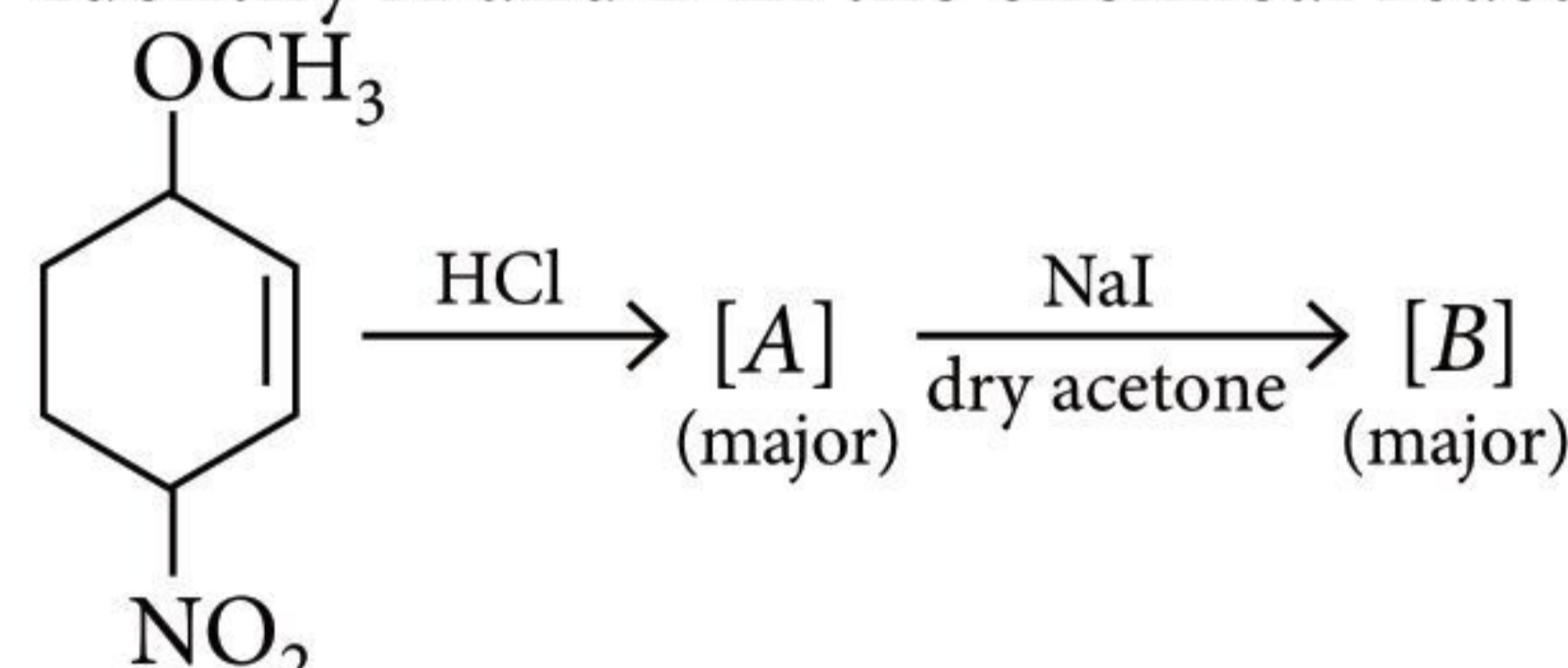
- (a) 1-Bromo-2-ethylpropane
 (b) 1-Bromo-2-ethyl-2-methylethane
 (c) 1-Bromo-2-methylbutane
 (d) 2-Methyl-1-bromobutane

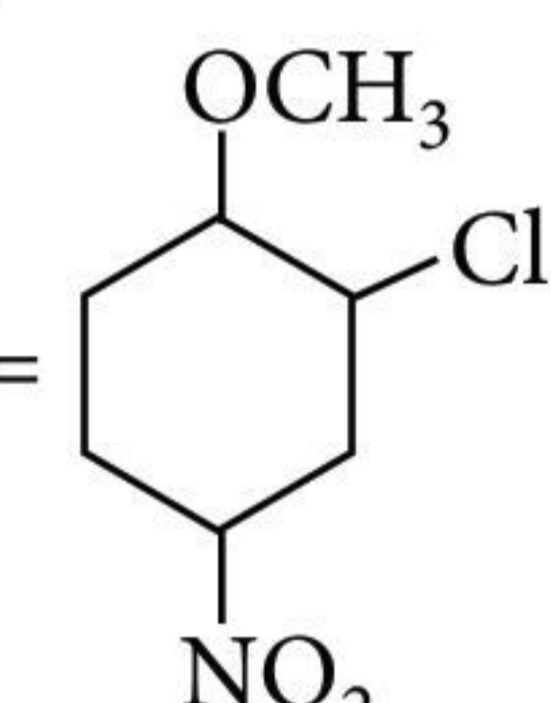
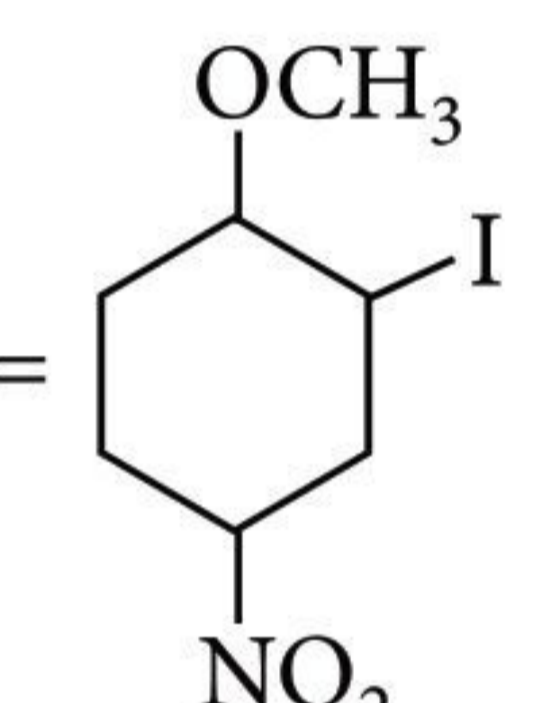
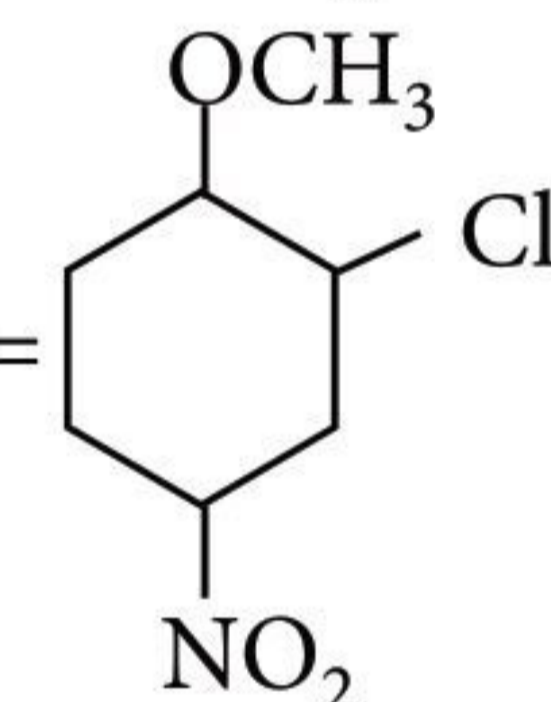
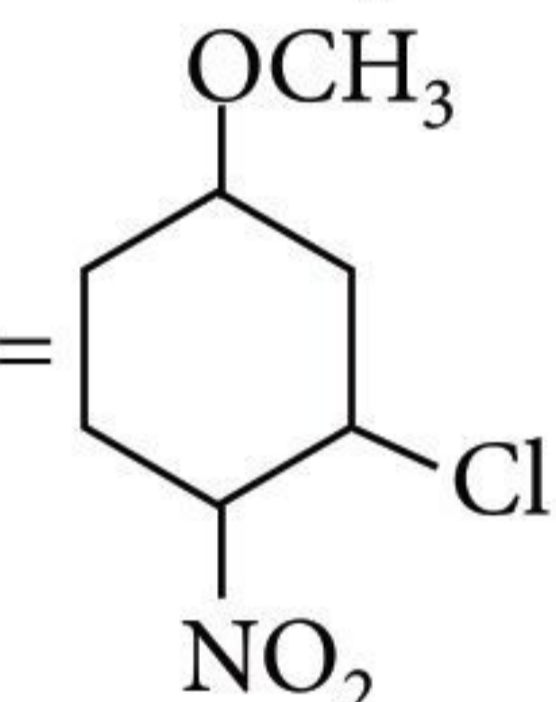
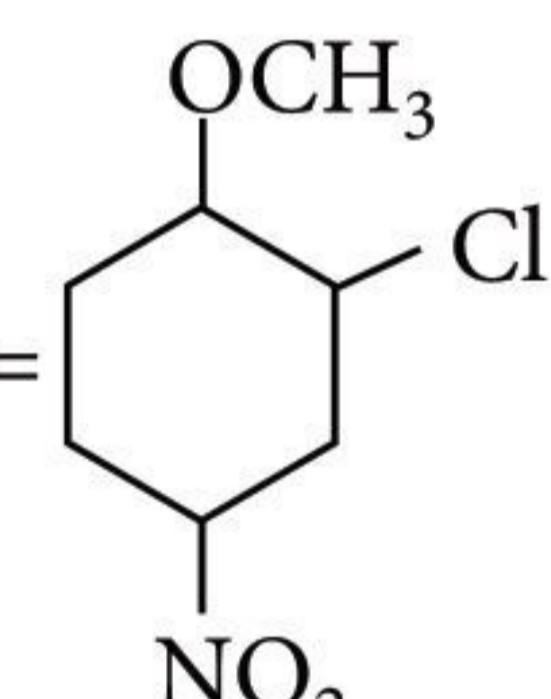
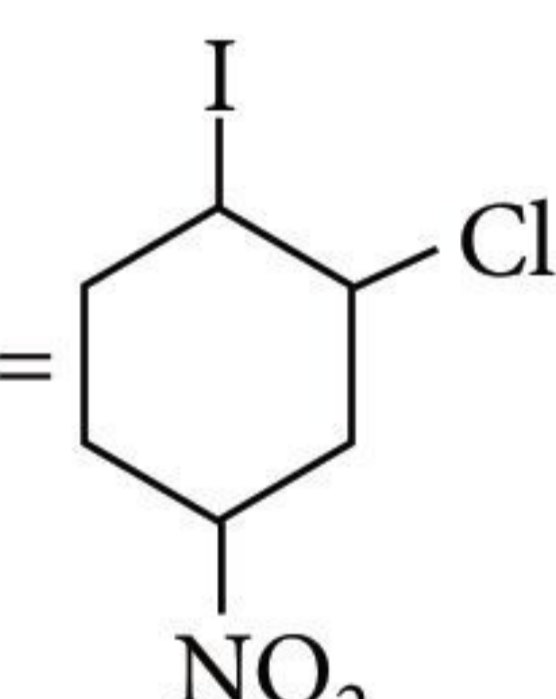
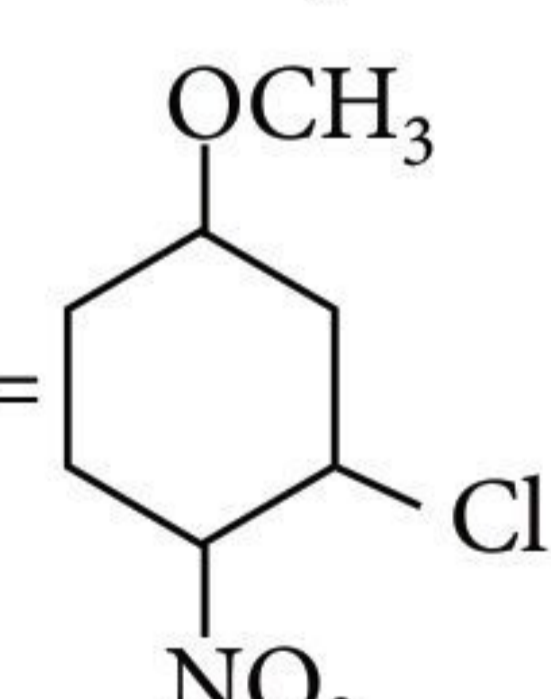
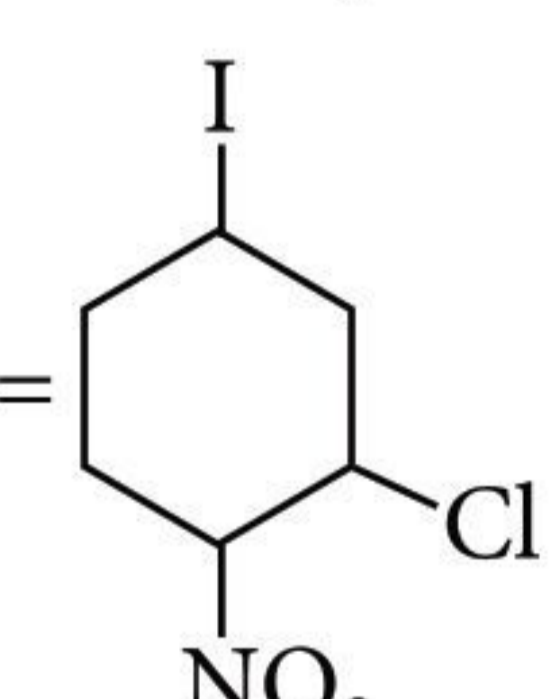


Which information below regarding this reaction is applicable?

- (a) It follows S_N2 pathway, because it is a primary alkyl chloride.
 (b) It follows S_N1 pathway, because the intermediate carbocation is resonance stabilized.
 (c) S_N1 pathway is not followed, because the intermediate carbocation is destabilised by $-I$ effect of oxygen.
 (d) A mixed S_N1 and S_N2 pathway is followed.

9. Identify A and B in the chemical reaction.



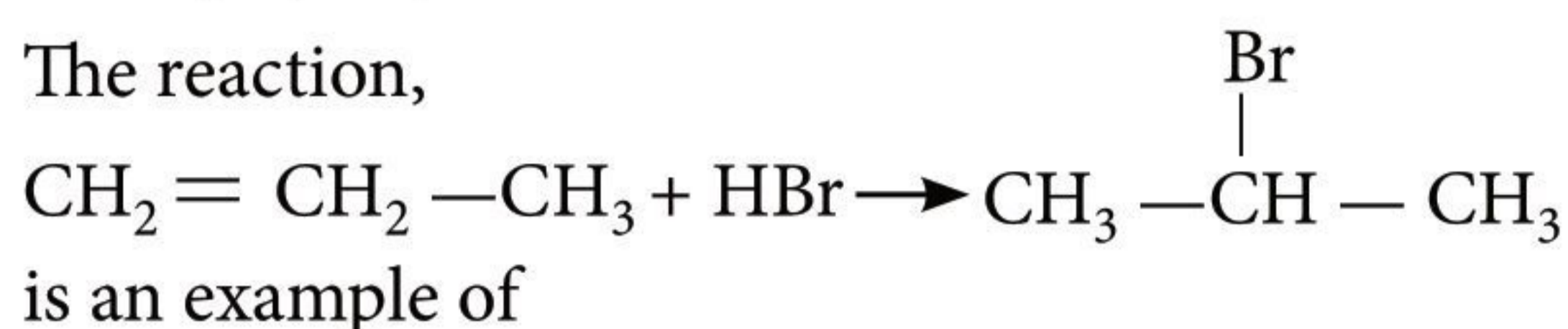
- (a) A =  B = 
 (b) A =  B = 
 (c) A =  B = 
 (d) A =  B = 

10. The negative part of the addendum (the molecule to be added) adds on to the carbon atom of the double bond containing the least number of hydrogen atoms. This rule is known as
 (a) Saytzeff's rule (b) Peroxide rule
 (c) Markovnikov's rule (d) van't Hoff rule.

11. Which of the following halide shows highest reactivity towards S_N1 reaction?

- (a) $\text{CH}_3 - \text{CH}_2\text{Cl}$
- (b) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2\text{I}$
- (c) $\text{C}_6\text{H}_5\text{Cl}$
- (d) $\text{C}_6\text{H}_5\text{CH}_2\text{Cl}$

12. The reaction,



- (a) nucleophilic addition
- (b) free radical addition
- (c) electrophilic addition
- (d) electrophilic substitution.

13. Which one of the following statements is false?

- (a) *R* and *S* configurations correspond to the enantiomers of an optically active compound.
- (b) The process of converting an optically active compound into a racemate is called racemization.
- (c) A molecule containing a plane of symmetry can be optically active.
- (d) Optical isomers that are not enantiomers are called diastereoisomers.

14. Which of the following compounds is responsible for depletion of ozone layer?

- (a) Freons
- (b) Chloroform
- (c) D.D.T.
- (d) Iodoform

15. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Nucleophilic substitution reaction on an optically active alkyl halide gives a mixture of enantiomers.

Reason : The reaction occurs by S_N2 mechanism.

Select the most appropriate answer from the options given below:

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

16. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Tertiary haloalkanes are more reactive than primary haloalkanes towards elimination reactions.

Reason : The +I-effect of the alkyl groups stabilises the tertiary carbocation.

Select the most appropriate answer from the options given below:

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

17. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : Isopropyl chloride is less reactive than CH_3Br in S_N2 reactions.

Reason : S_N2 reactions are always accompanied by inversion of configuration.

Select the most appropriate answer from the options given below:

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

18. Given below are two statements labelled as Assertion (A) and Reason (R).

Assertion : *n*-Butyl bromide has higher boiling point than isobutyl bromide.

Reason : The branching of the chain makes the molecule more compact and therefore decreases the surface area.

Select the most appropriate answer from the options given below:

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

SECTION B

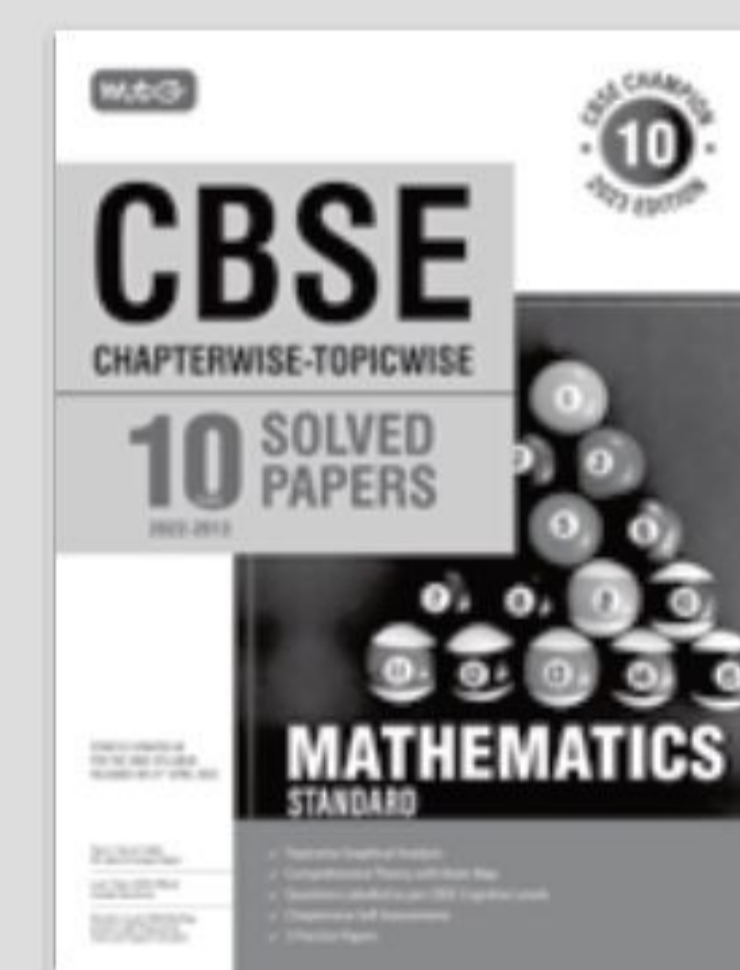
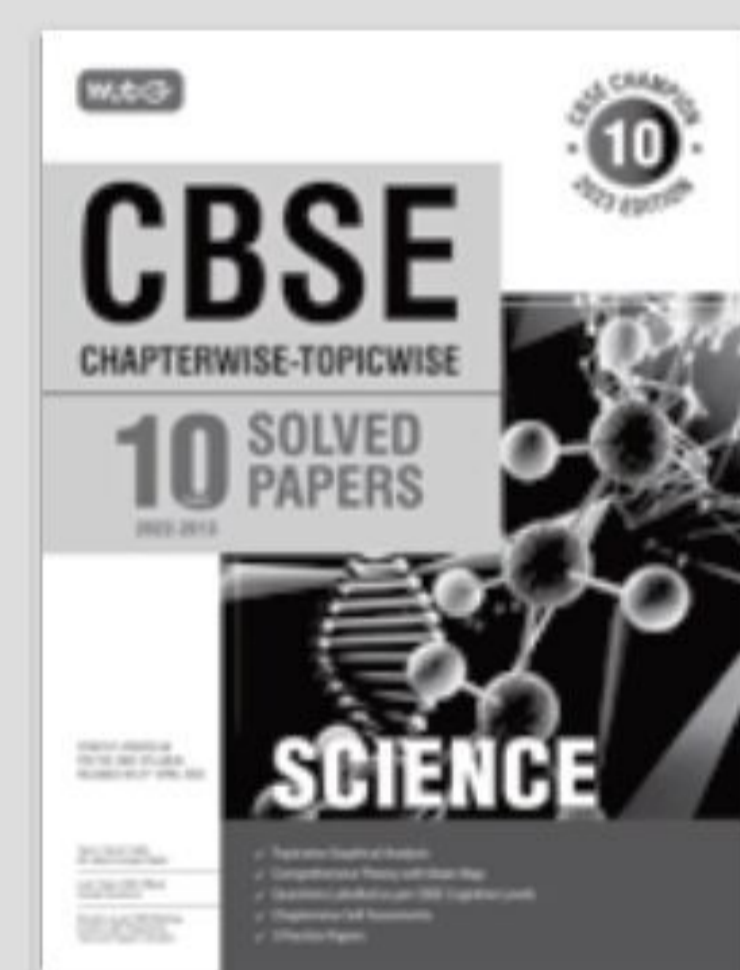
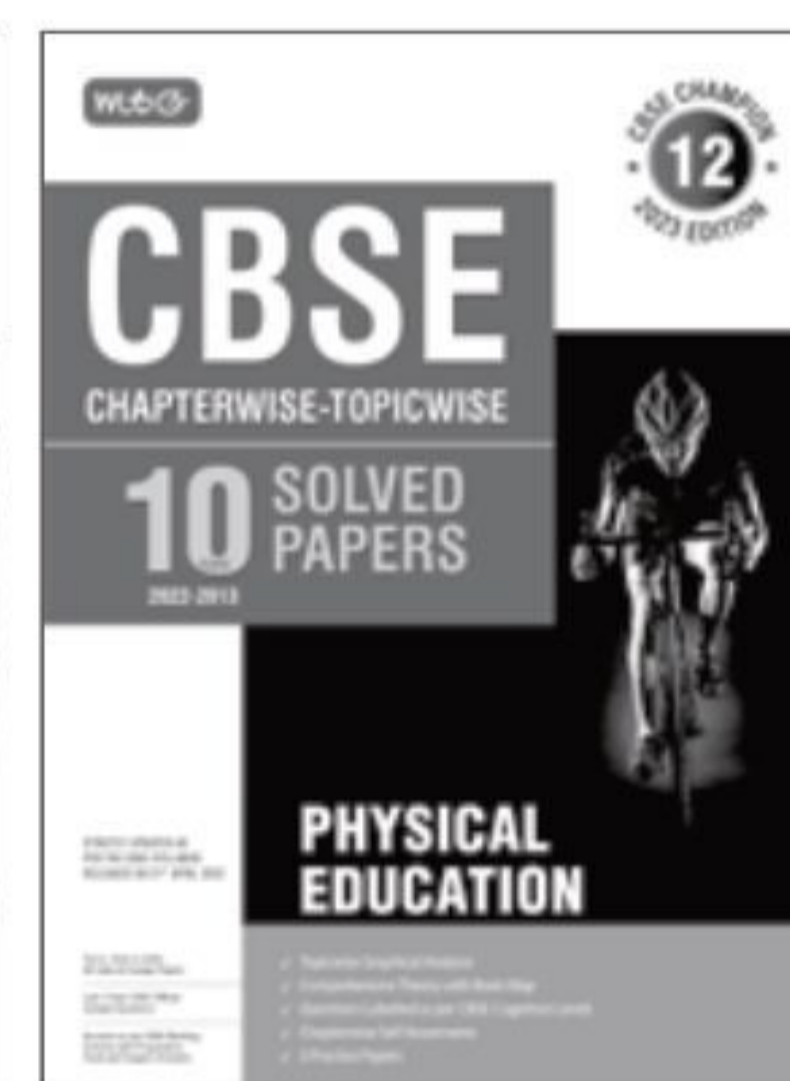
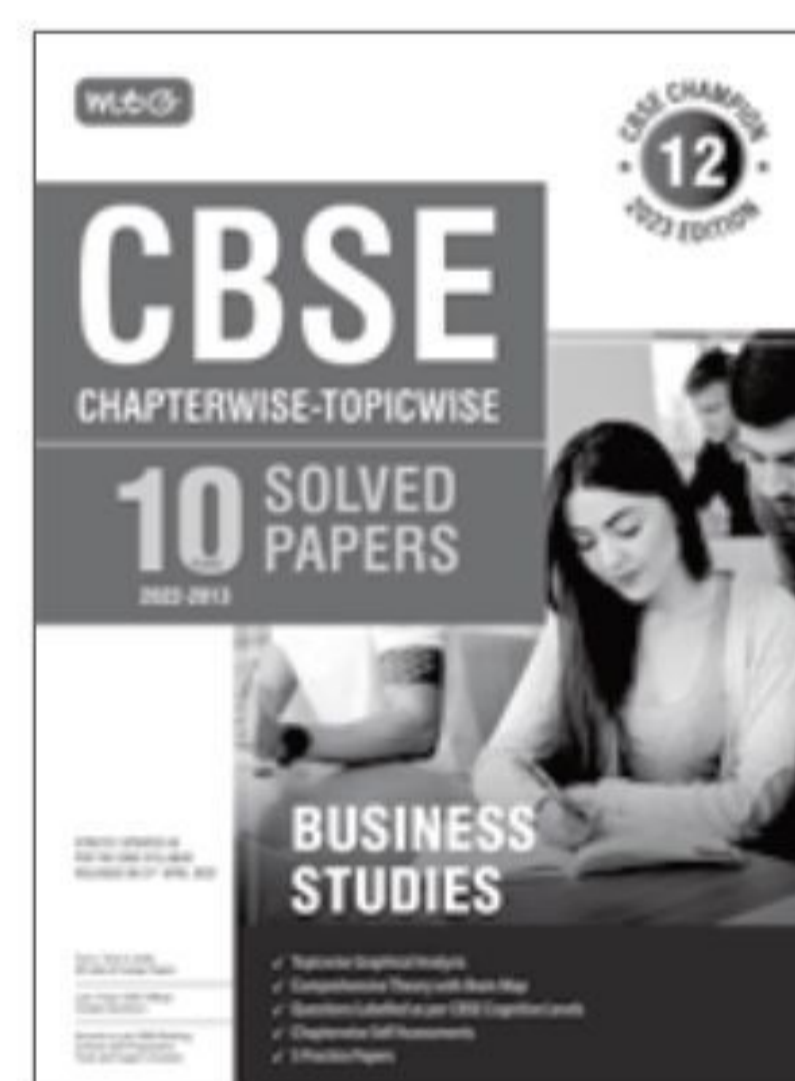
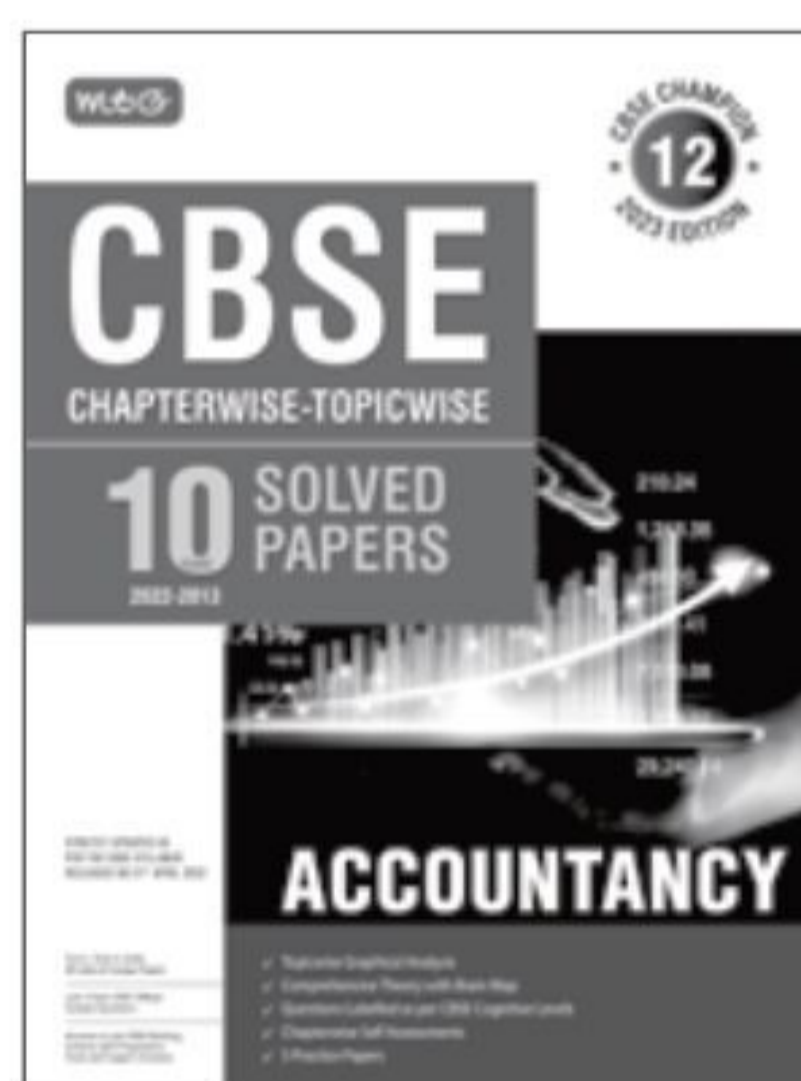
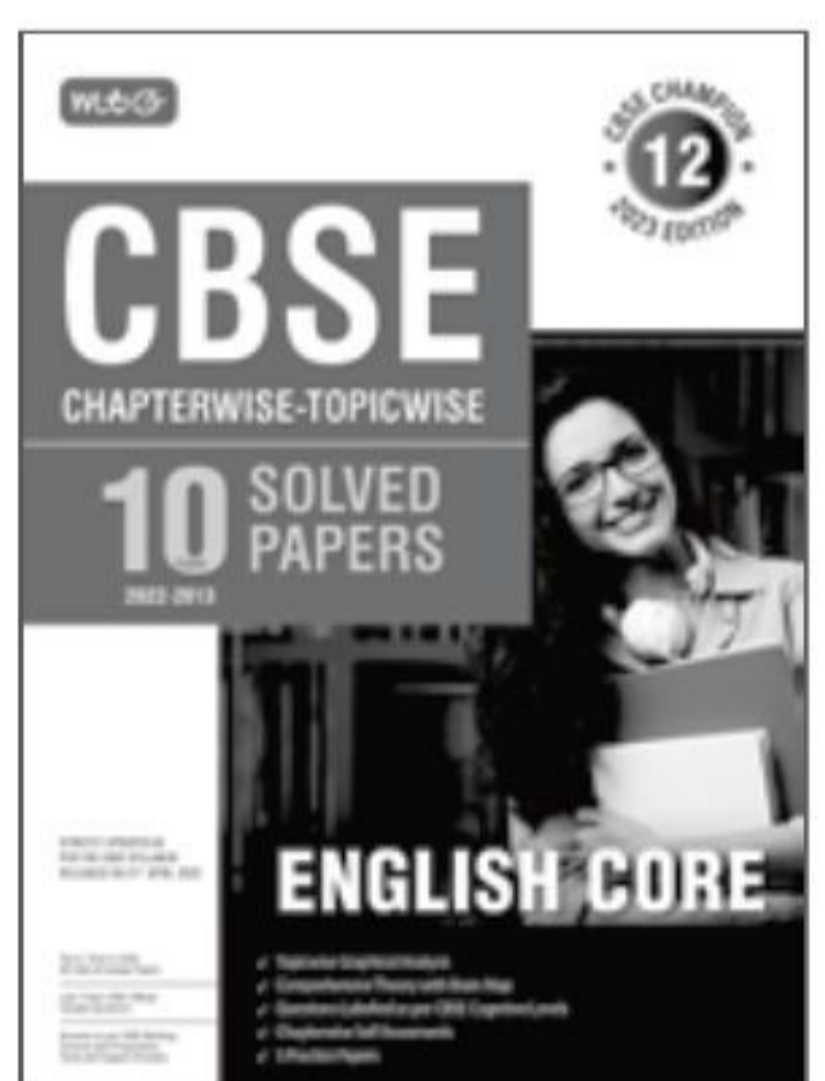
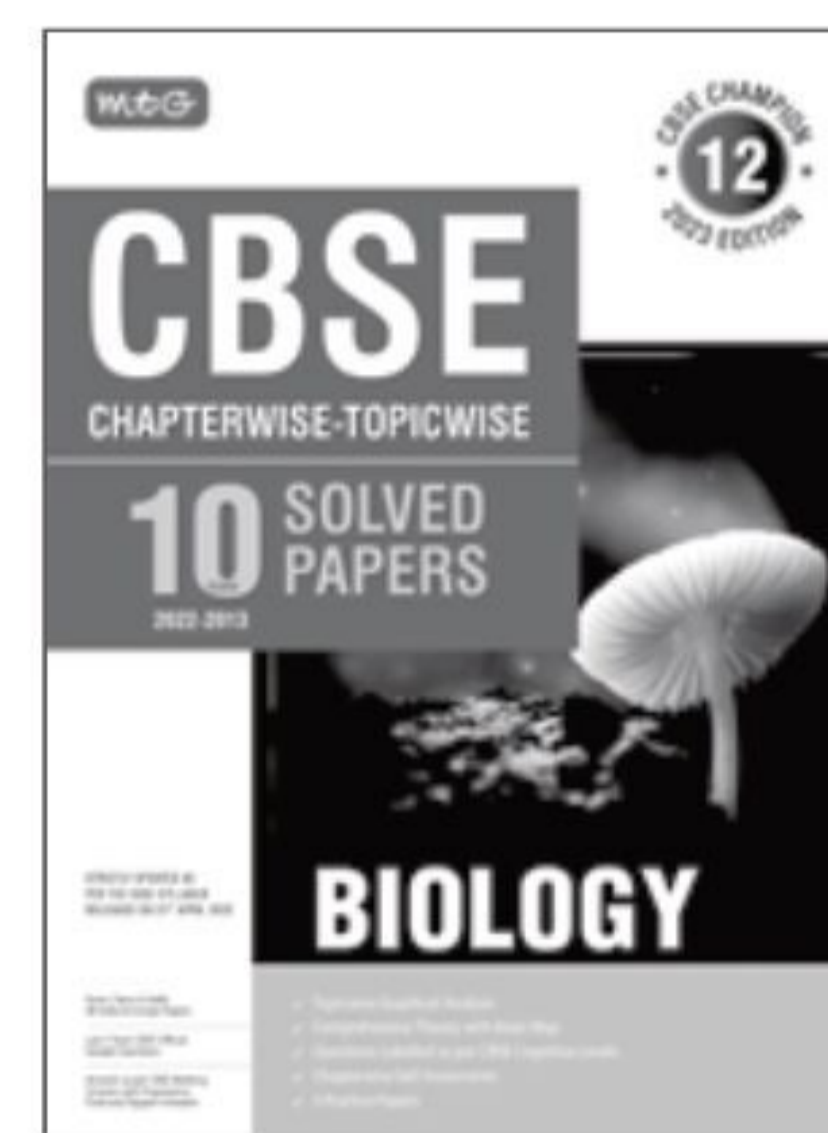
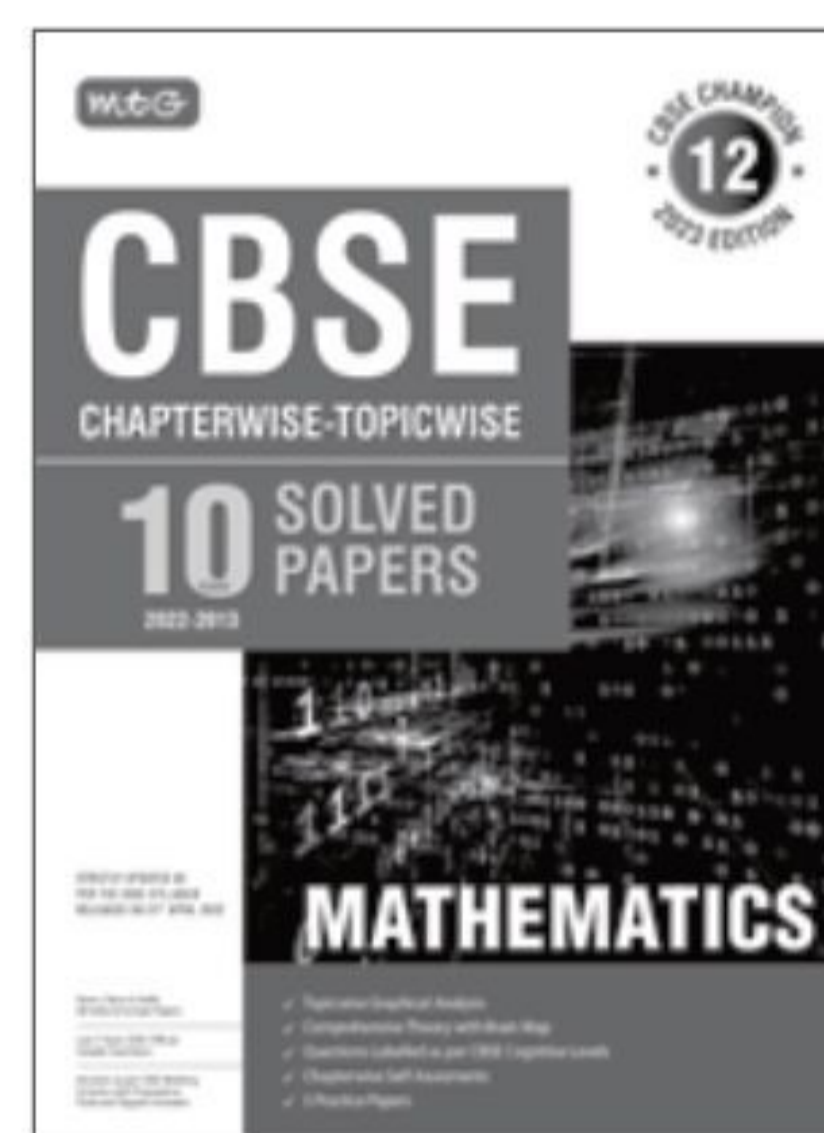
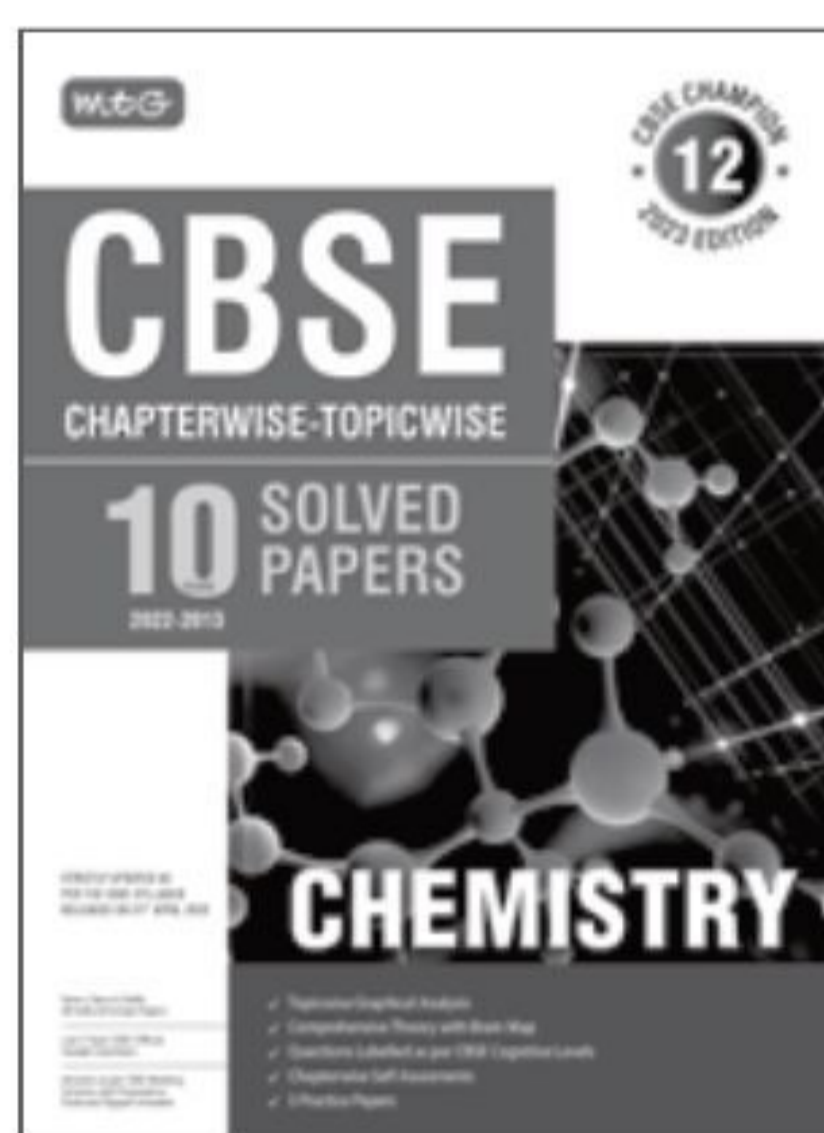
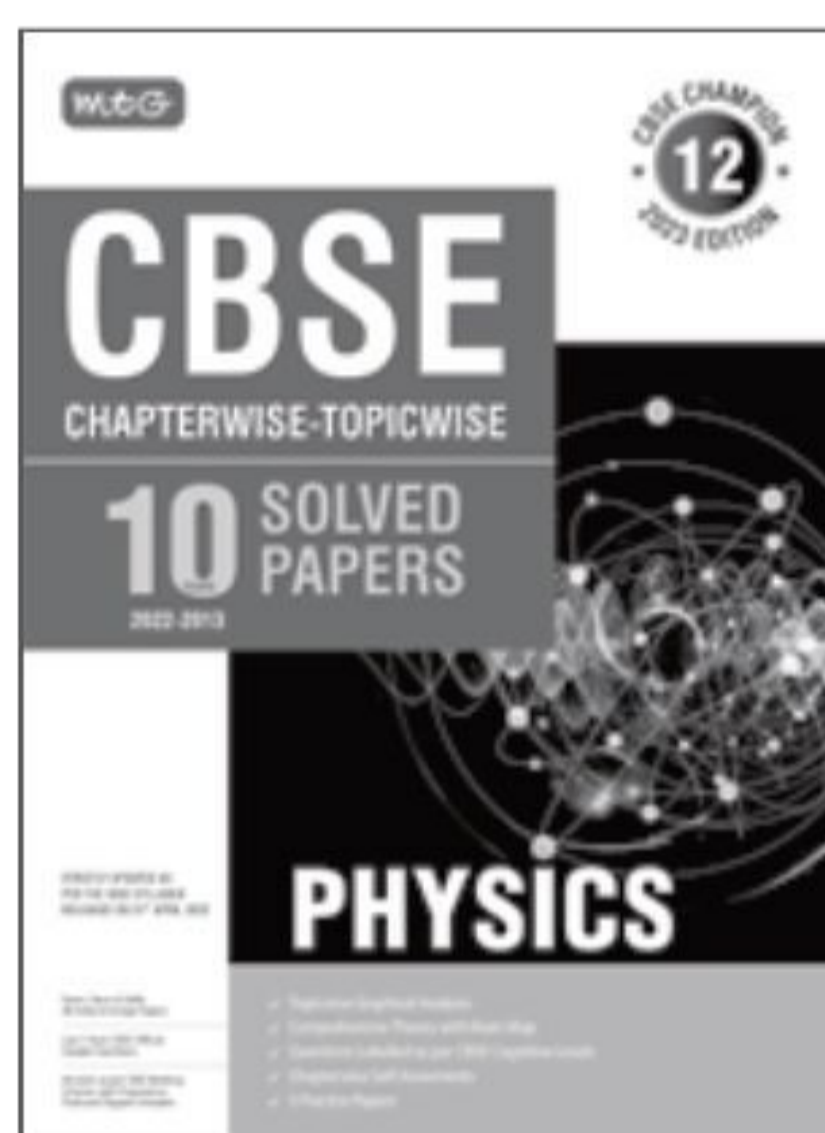
This section contains 7 questions with internal choice in two questions. The following questions are very short answer type and carry 2 marks each.

19. The following haloalkanes are hydrolysed in presence of aq. KOH :

- (i) 2-Chlorobutane



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HIGHLIGHTS OF 2022-23 EDITION

- Based on Reduced Syllabus
- Topicwise Graphical Analysis
- Quick Recap with Brain Map
- Previous 10 years (2022- 2013) questions of CBSE
- CBSE Cognitive Level Tagging
- Key Points, Answer Tips, Concept Applied, Shortcuts, Alternating Methods, Commonly Made Mistakes provided
- CBSE Topper's Answers
- Past 3 years CBSE Sample Question Papers
- Chapterwise Self-Assessment
- 5 Practice Papers



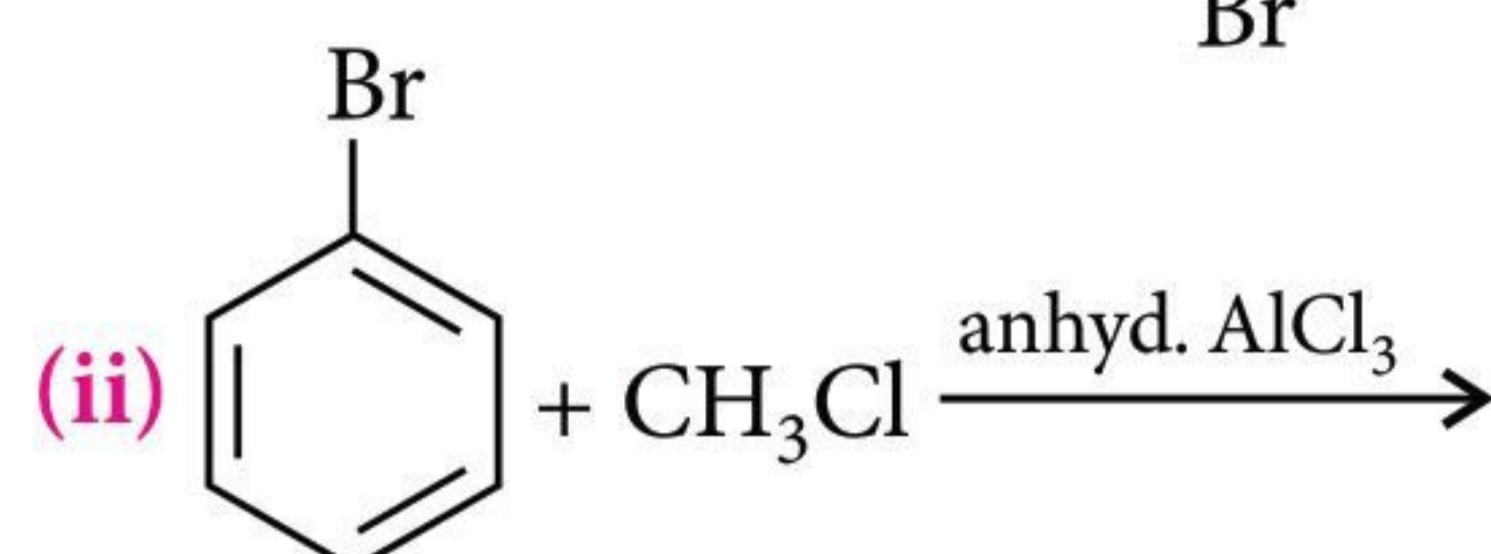
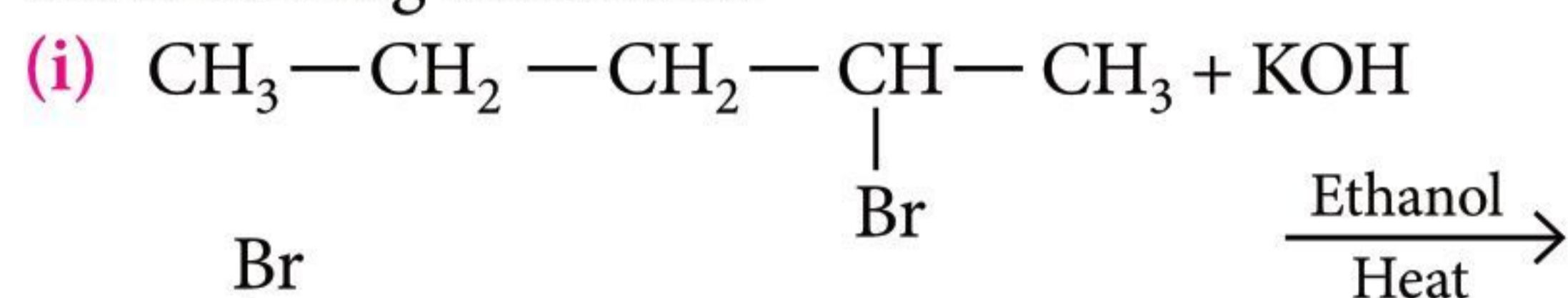
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(ii) 2-Chloro-2-methylpropane

Which of the above is most likely to give a racemic mixture? Justify your answer.

20. Write the structure of the major product in each of the following reactions :



OR

- (a) Write the IUPAC names of the following compounds:



- (b) Write the structure of the compound:
1-chloro-4-ethylcyclohexane.

21. Give reason for the following:

- (a) Grignard reagents are prepared strictly under anhydrous conditions.
(b) Alkyl halides, though polar, are immiscible with water.

22. Write chemical equations when

- (a) ethyl chloride is treated with aqueous KOH.
(b) chlorobenzene is treated with CH_3COCl in presence of anhydrous AlCl_3 .

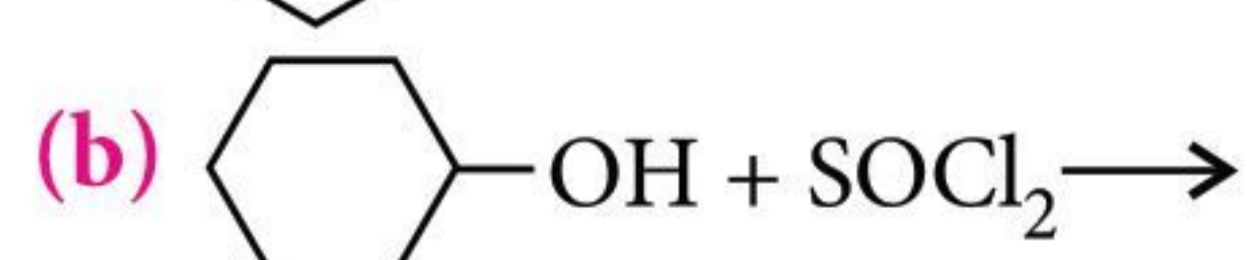
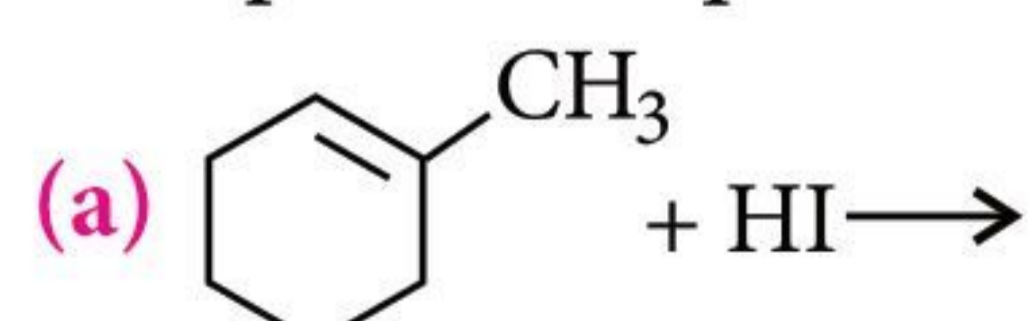
OR

- (a) Out of $(\text{CH}_3)_3\text{C}-\text{Br}$ and $(\text{CH}_3)_3\text{C}-\text{I}$, which one is more reactive towards $\text{S}_\text{N}1$ and why?
(b) Why *dextro* and *laevo*-rotatory isomers of Butan-2-ol are difficult to separate by fractional distillation?

23. Write chemical equations when

- (a) methyl chloride is treated with AgNO_2 ;
(b) bromobenzene is treated with CH_3Cl in the presence of anhydrous AlCl_3 .

24. Complete the equations for the following reactions :



25. Carry out the following conversions in not more than 2 steps :

- (a) Aniline to chlorobenzene
(b) 2-Bromopropane to 1-bromopropane

SECTION C

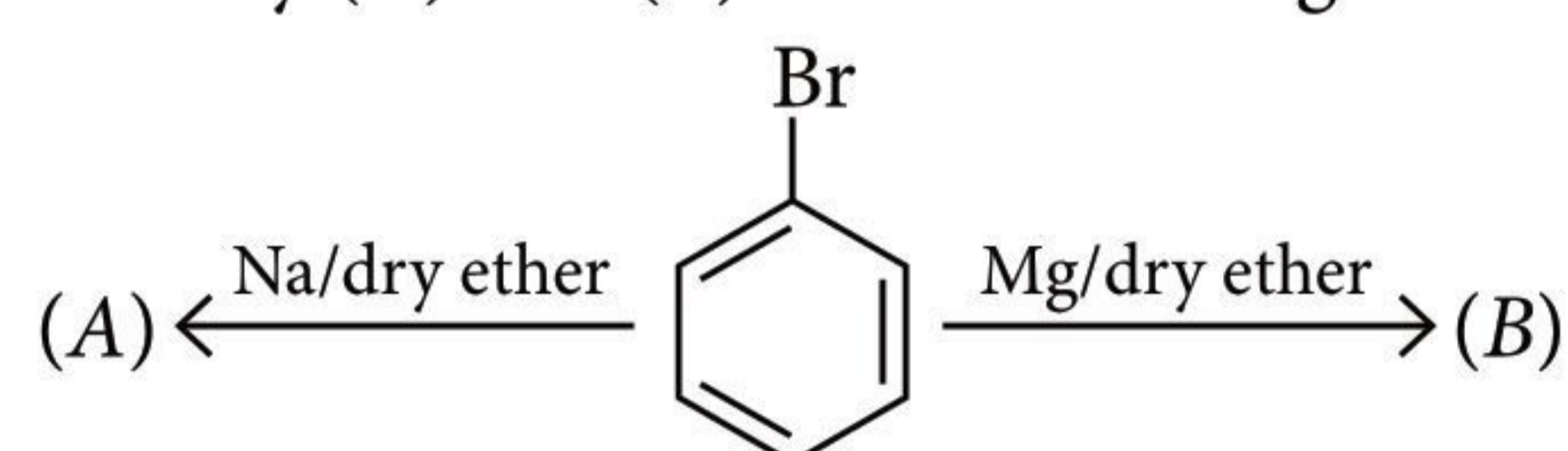
This section contains 5 questions with internal choice in two questions. The following questions are short answer type and carry 3 marks each.

26. (a) Write the structure of major alkene formed by β -elimination of 2, 2, 3-trimethyl-3-bromopentane with sodium ethoxide in ethanol.

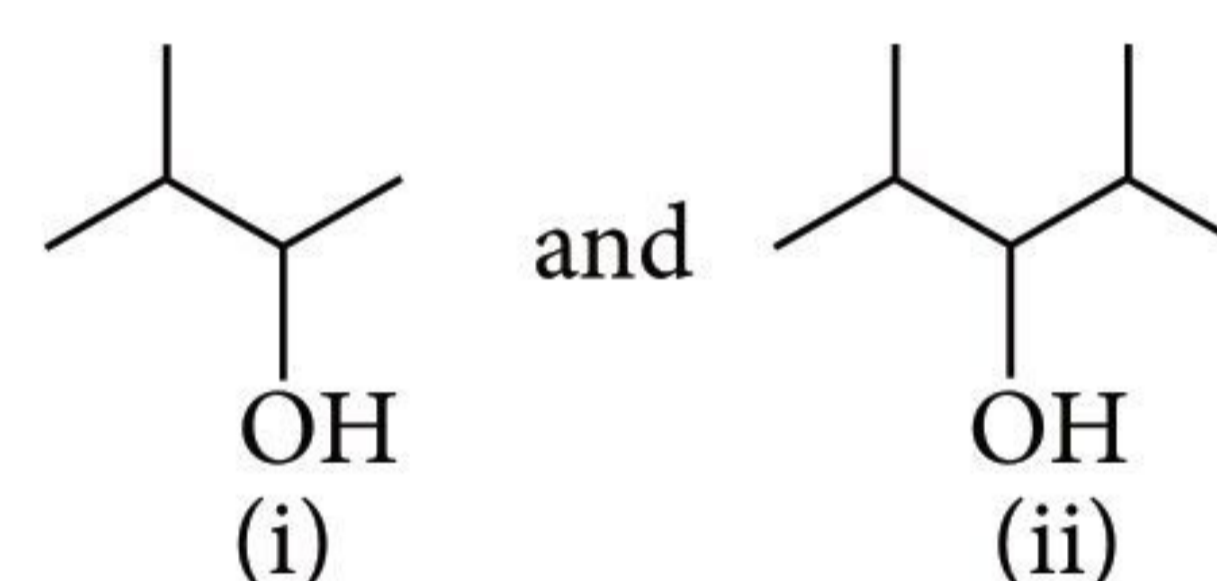
- (b) Which one of the compounds in the following pairs is chiral?



- (c) Identify (A) and (B) in the following :



27. (a) Identify the chiral molecule in the following pair :



- (b) Write the structure of the product when chlorobenzene is treated with methyl chloride in the presence of sodium metal and dry ether.
(c) Write the structure of the alkene formed by dehydrohalogenation of 1-bromo-1-methylcyclohexane with alcoholic KOH.

28. Following compounds are given to you:

2-Bromopentane, 2-Bromo-2-methylbutane, 1-Bromopentane

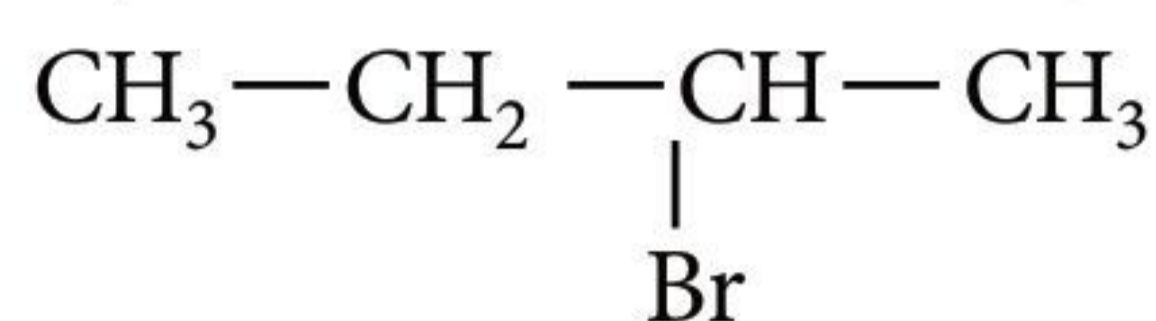
- (a) Write the compound which is most reactive towards $\text{S}_\text{N}2$ reaction.
(b) Write the compound which is optically active.
(c) Write the compound which is most reactive towards β -elimination reaction.

OR

- (a) Although chlorine is an electron withdrawing group, yet it is *ortho*-, *para*-directing in electrophilic aromatic substitution reactions. Why?
(b) Write the product formed when *p*-nitrochlorobenzene is heated with aqueous NaOH at 443 K followed by acidification.
(c) Why is (\pm) -butan-2-ol optically inactive?

29. Answer the following questions:

- (a) Which alkyl halide from the following pairs would you expect to react more rapidly by an S_N2 mechanism and why?



- (b) Racemisation occurs in S_N1 reactions. Why?

30. Give reasons for **any three** of the following observations:

- The C—Cl bond length in chlorobenzene is shorter than that in $\text{CH}_3\text{—Cl}$.
- Chloroform is stored in closed dark brown bottles.
- Ethyl iodide undergoes S_N2 reaction faster than ethyl bromide.
- Which is more easily hydrolysed by aqueous KOH among $\text{C}_6\text{H}_5\text{CH}_2\text{Cl}$ and $\text{C}_6\text{H}_5\text{CHClC}_6\text{H}_5$.

SECTION D

The following questions are case-based questions. Each question has an internal choice and carries 4 (1+1+2) marks each. Read the passage carefully and answer the questions that follow.

31. The substitution reaction of alkyl halide mainly occurs by S_N1 or S_N2 mechanism. Whatever mechanism alkyl halides follow for the substitution reaction to occur, the polarity of the carbon halogen bond is responsible for these substitution reactions. The rate of S_N1 reactions are governed by the stability of carbocation whereas for S_N2 reactions steric factor is the deciding factor. If the starting material is a chiral compound, we may end up with an inverted product or racemic mixture depending upon the type of mechanism followed by alkyl halide. Cleavage of ethers with HI is also governed by steric factor and stability of carbocation, which indicates that in organic chemistry, these two major factors help us in deciding the kind of product formed.

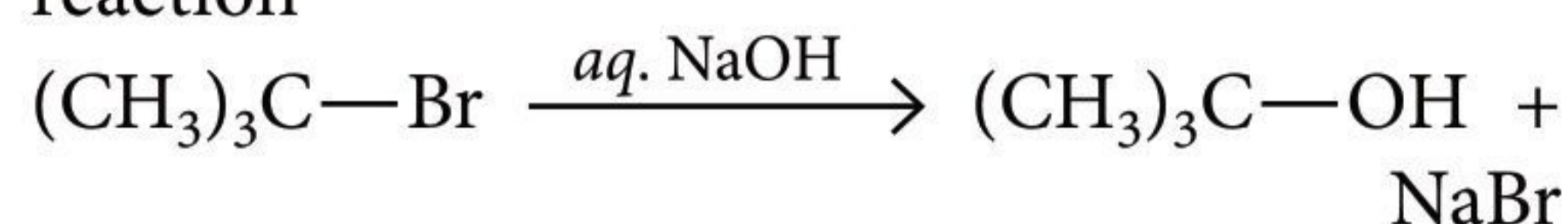
Answer the following questions :

- Predict the stereochemistry of the product formed if an optically active alkyl halide undergoes substitution reaction by S_N1 mechanism.
- Name the instrument used for measuring the angle by which the plane polarised light is rotated.

- Predict the major product formed when 2-bromopentane reacts with alcoholic KOH.

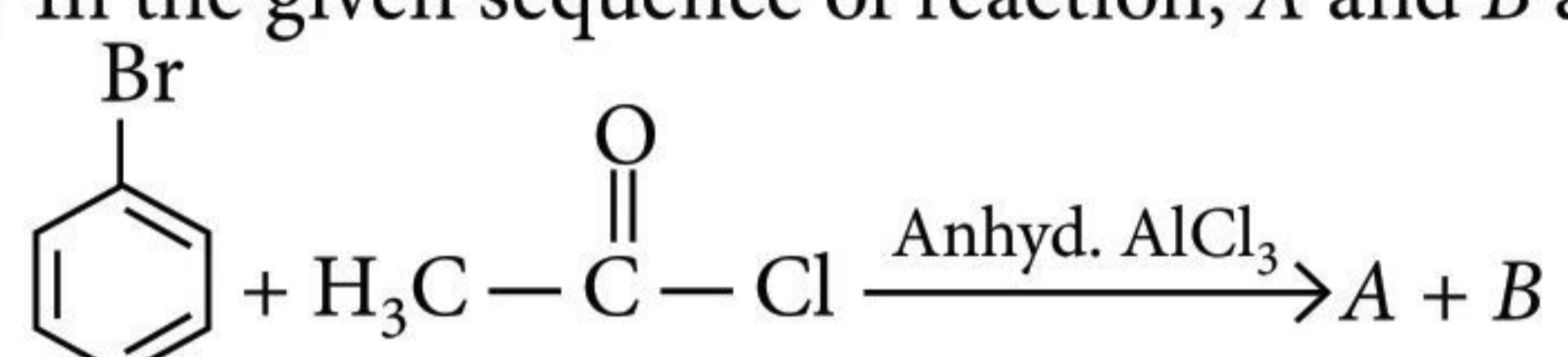
OR

Write the mechanism of the following S_N1 reaction



32. Haloarenes undergo the usual electrophilic substitution of the benzene ring such as halogenation, nitration, sulphonation and Friedel-Crafts reactions. Halogen atom besides being slightly deactivating is *ortho*, *para* directing, therefore further substitution occurs at *ortho* and *para* positions with respect to the halogen atom. Due to resonance, the electron density increases more at *ortho* and *para* position than at *meta* positions. Further, the halogen atom because of its $-I$ effect has some tendency to withdraw electrons from the benzene ring. As a result, electrophilic substitution reactions in haloarenes occurs slowly and require more drastic conditions as compared to that in benzene.

Answer the following questions :

- What will be the major product of chlorination of chlorobenzene in presence of anhydrous FeCl_3 ?
- In the given sequence of reaction, A and B are

- What will be the major product obtained when chlorobenzene reacts with a mixture of HNO_3 and H_2SO_4 ?

OR

When bromobenzene is monochlorinated, two isomeric compounds (A) and (B) are obtained. Monobromination of (A) gives several isomeric

UNSCRAMBLED WORDS

OCTOBER 2022

- | | |
|--------------------------|-----------------|
| 1-b- ULTRACENTRIFUGATION | 3-e- HERBICIDE |
| 2-c- BRASS | 5-a- ABSORPTION |
| 4-f- LUBRICANT | 8-i- REFINING |
| 6-d- MACROMOLECULE | 10-g- SINTERING |
| 7-j- PIPETTE | |
| 9-h- SOLVOLYSIS | |

Winner: Kiran Joshy

products of formula $C_6H_3ClBr_2$. Identify the structures of A, B and all the products formed on monobromination of A.

SECTION E

The following questions are long answer type and carry 5 marks each. Two questions have an internal choice.

33. (a) Haloalkanes easily dissolve in organic solvents, why?
 (b) Write the structure of all the possible isomers of dichloroethene. Which of them will have zero dipole moment?
 (c) Explain the given trend of the boiling point of the following :
 $MeI > MeBr > MeCl > MeF > CH_4$

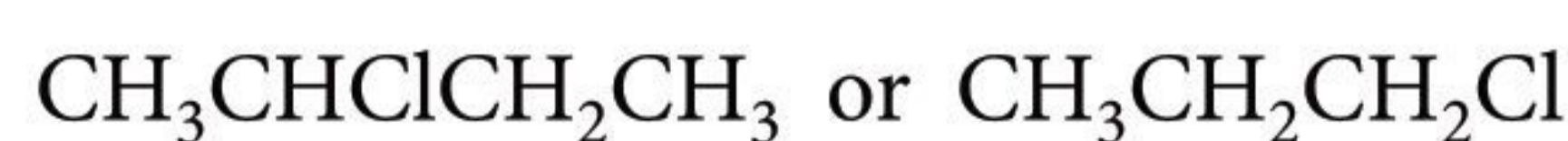
OR

- (a) Allyl chloride is hydrolysed more readily than *n*-propyl chloride. Why?
 (b) Haloalkanes undergo nucleophilic substitution whereas haloarenes undergo electrophilic substitution.
 (c) Out of the various possible isomers of C_7H_7Cl containing benzene ring, suggest the structure with the weakest C—Cl bond.
34. (a) Predict the major product formed when HCl is added to isobutylene. Explain the mechanism involved.
 (b) Cyanide ion acts as an ambident nucleophile. From which end it acts as a stronger nucleophile in aqueous medium? Give reason for your answer.
 (c) Why are alkyl halides generally not prepared in the laboratory by free radical halogenation of alkanes?

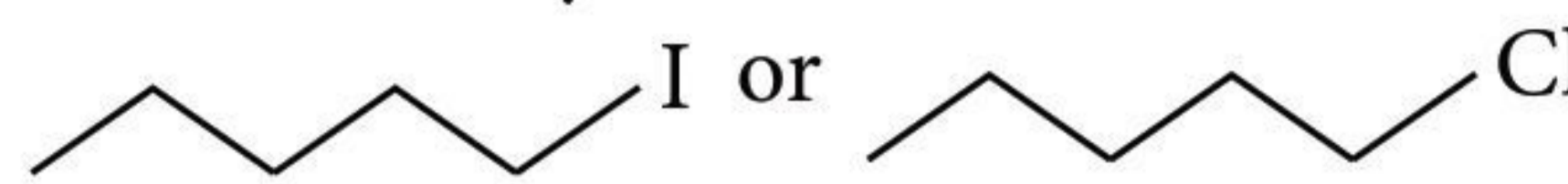
OR

Give chemical reactions for the following:

- Nitration of chlorobenzene
 - Sulphonation of chlorobenzene
 - Alkylation of chlorobenzene
 - Acylation of chlorobenzene
 - Chlorination of chlorobenzene
35. Answer the following questions:
 (a) What is meant by chirality of a compound? Give an example.
 (b) Which one of the following compounds is more easily hydrolysed by KOH and why?

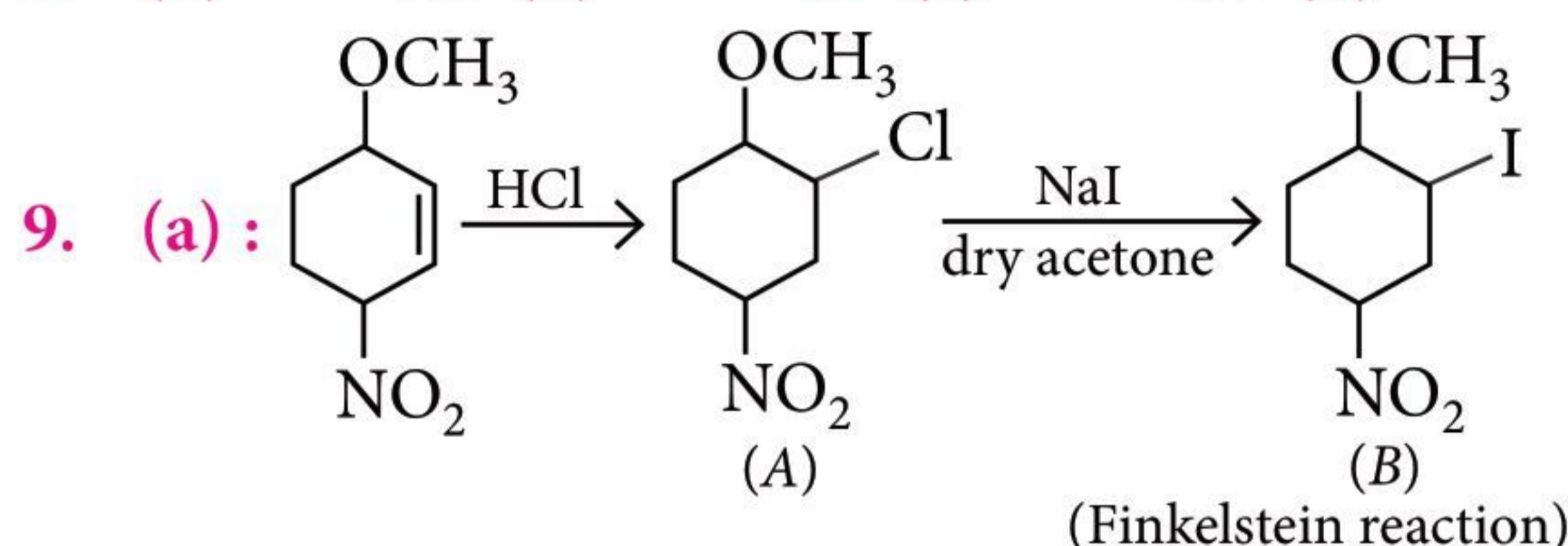


- (c) Which one undergoes S_N2 substitution reaction faster and why?

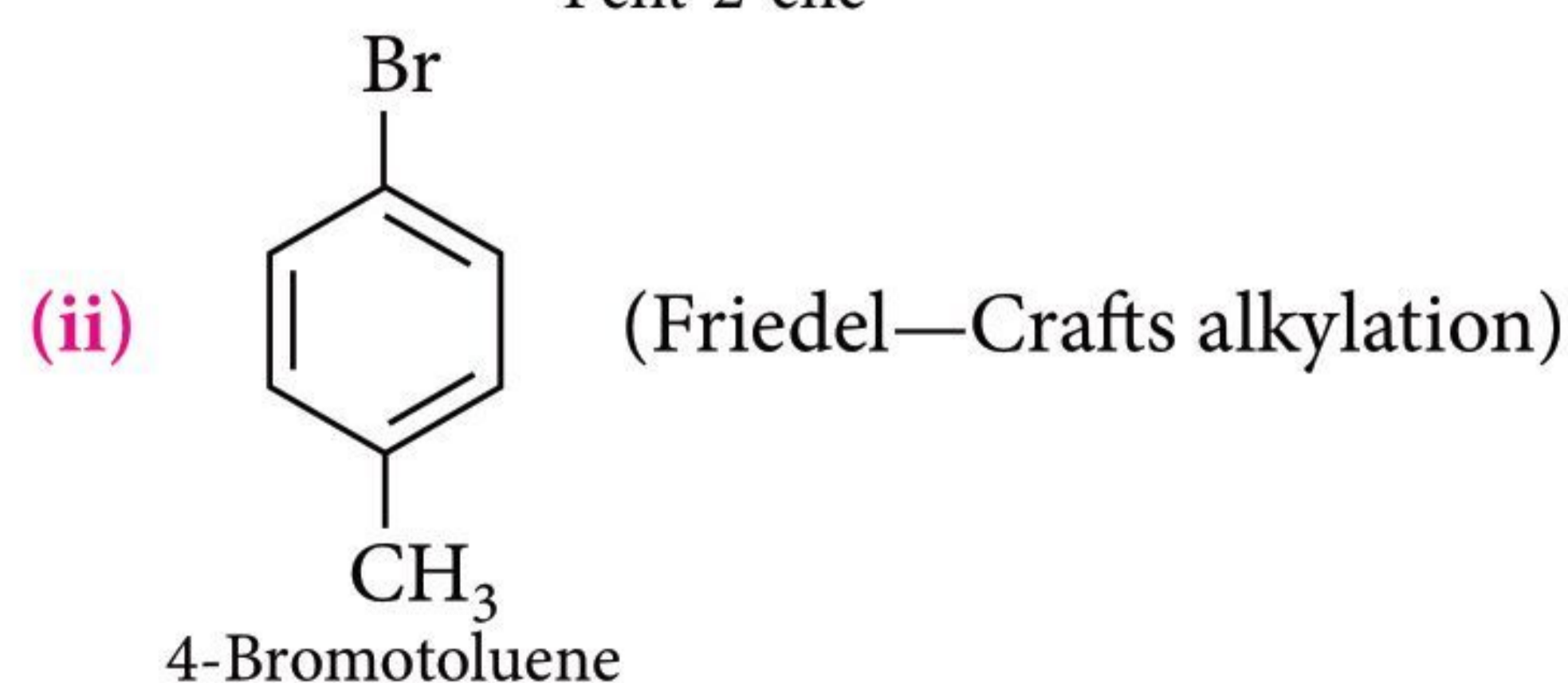


SOLUTIONS

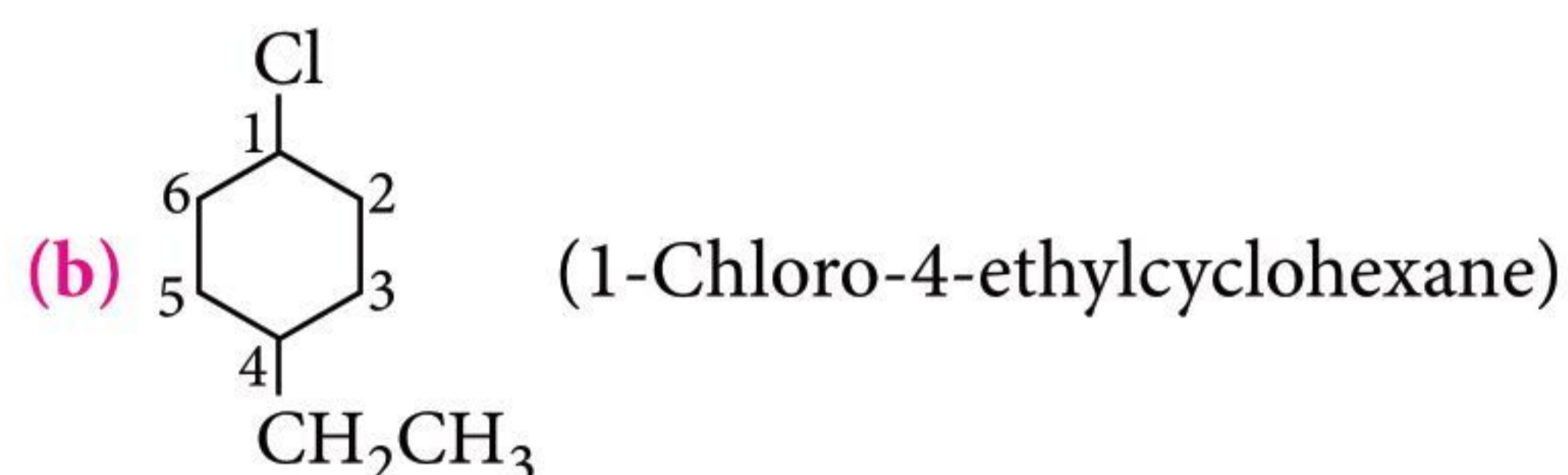
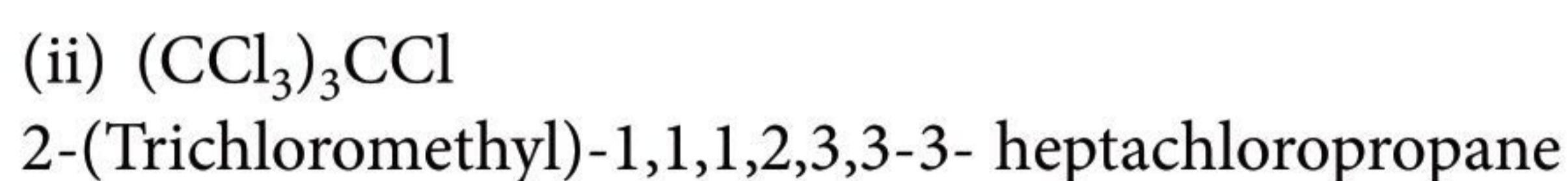
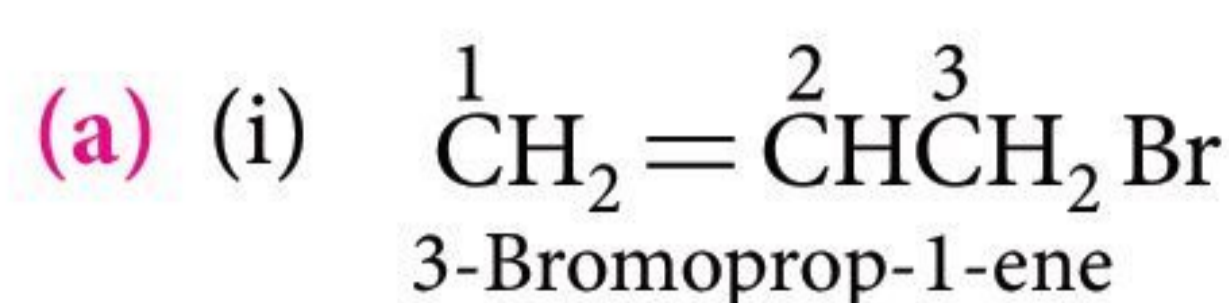
1. (a) 2. (a) 3. (c) 4. (b)
 5. (d) 6. (b) 7. (c) 8. (d)



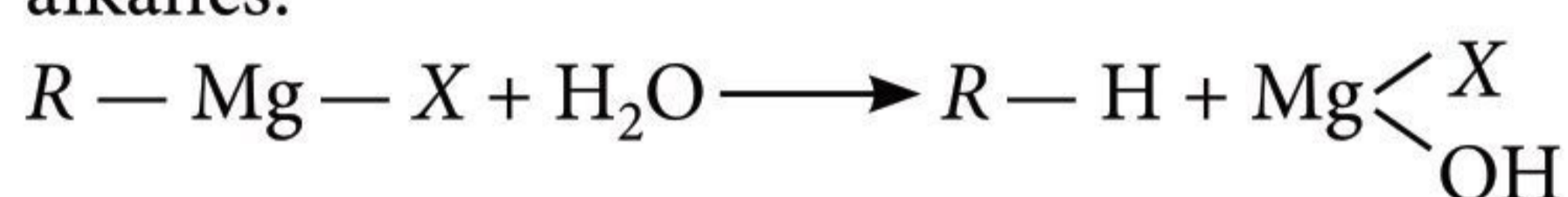
10. (c) 11. (d)
 12. (c) : Alkenes undergo electrophilic addition with hydrogen halide.
 13. (c) : A molecule containing plane of symmetry cannot be optically active.
 14. (a) : Freons are chlorofluorocarbons introduced into the atmosphere from aerosol sprays and refrigerating equipments. They have a very long life time and when they reach stratosphere, they undergo photochemical decomposition and destroy ozone.
 15. (c) 16. (a)
 17. (b) : As the size of the alkyl group increases, the S_N2 reactivity decreases, further C—Cl bond is stronger and more difficult to cleave than C—Br bond. So, CH_3Br is more reactive than $(CH_3)_2CHCl$.
 18. (a) : Branching of chain makes molecule more compact and therefore, decreases the surface area. Due to decrease in surface area, the magnitude of van der Waals' force of attraction decreases and consequently, the boiling points of branched chain are less than those of straight chain compounds.
 19. Racemic mixture will be given by 2-chlorobutane as it is an optically active compound. When 2-chlorobutane undergoes S_N1 reaction, both front and rear attack are possible, resulting in a racemic mixture.
 20. (i) $CH_3-CH_2-CH=CH-CH_3$ (Saytzeff rule)



OR



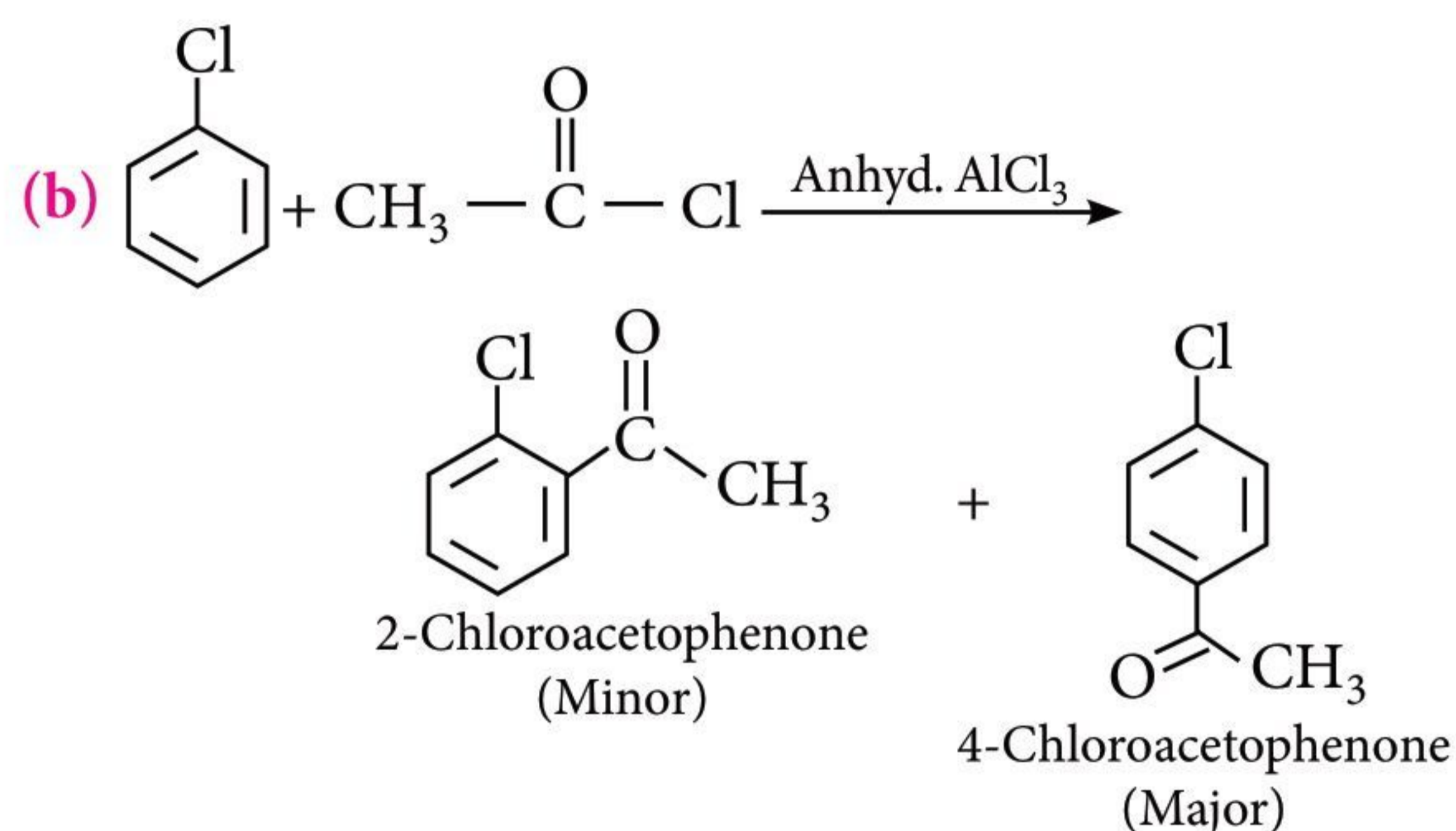
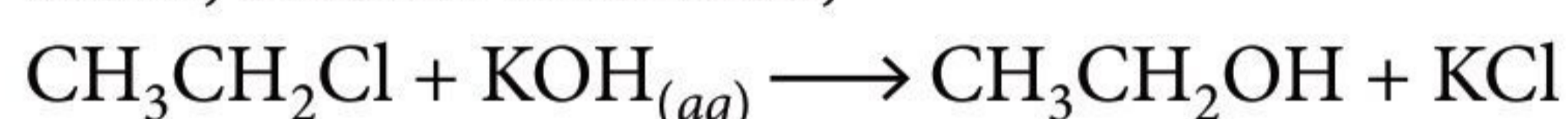
21. (a) Grignard reagents react with water to form alkanes.



So, they must be prepared under anhydrous conditions.

(b) Alkyl halides are polar but are insoluble in water because energy required to break the intermolecular hydrogen bonding among water molecules is much higher than energy released by water halide interaction.

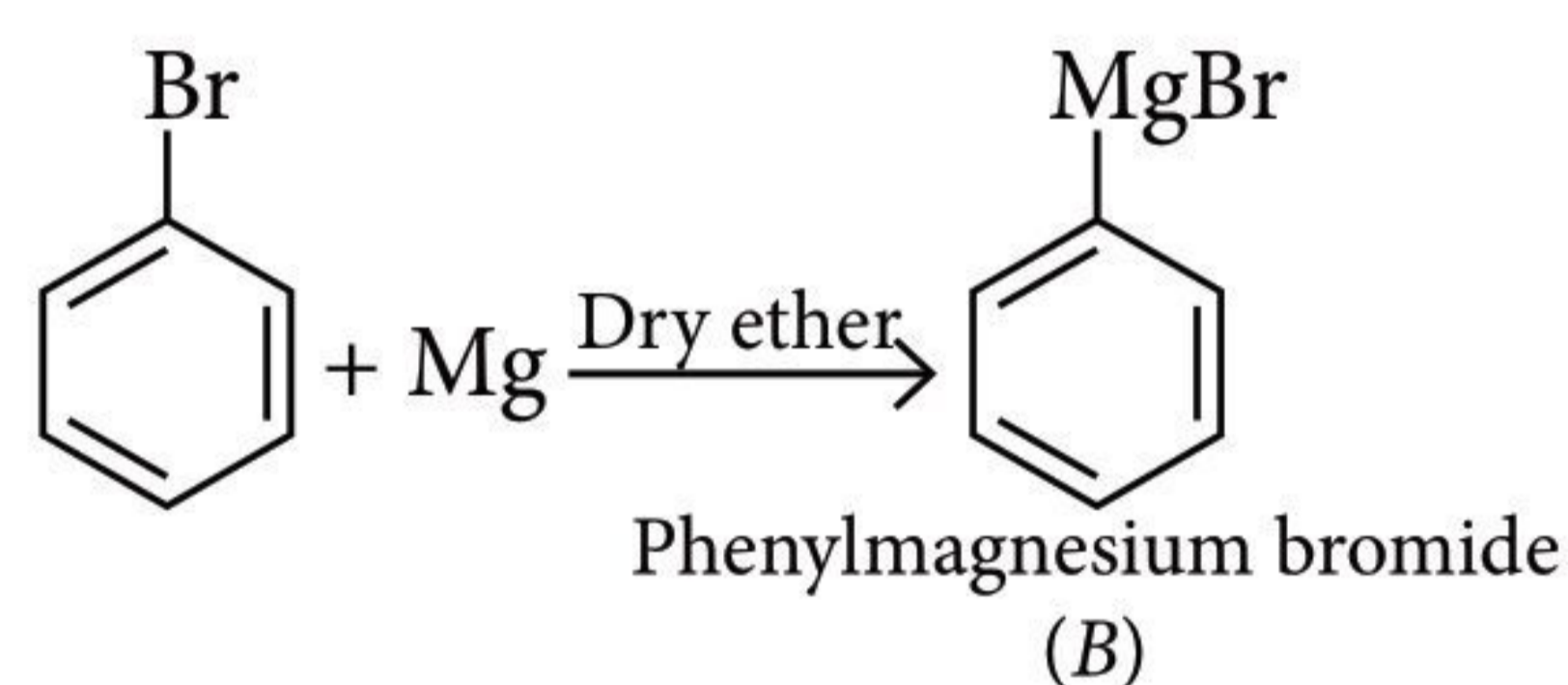
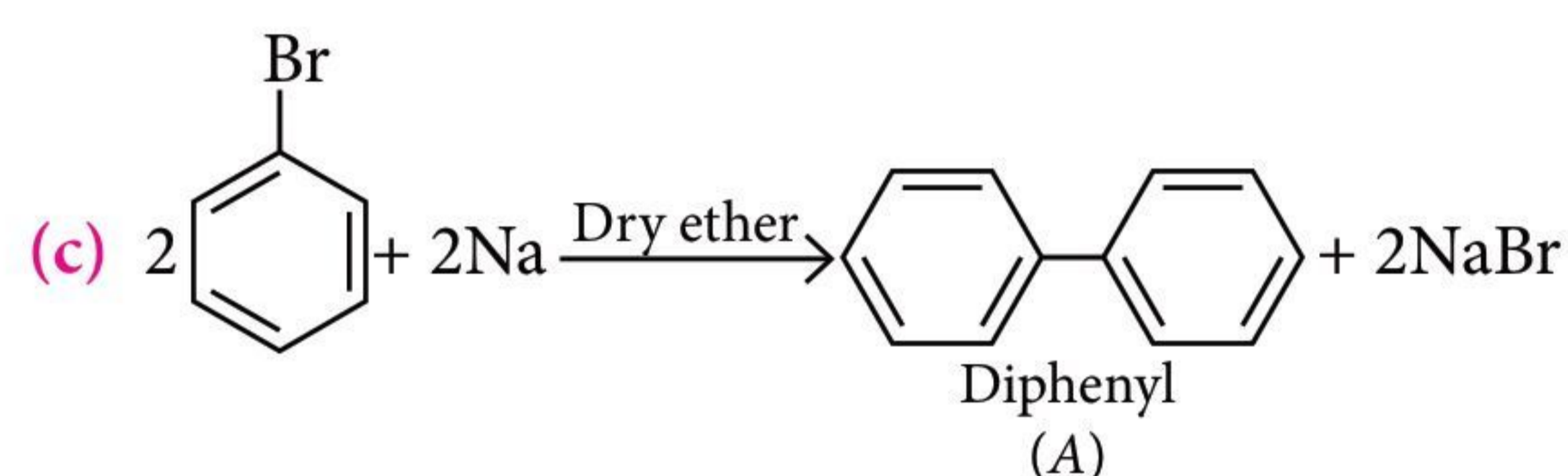
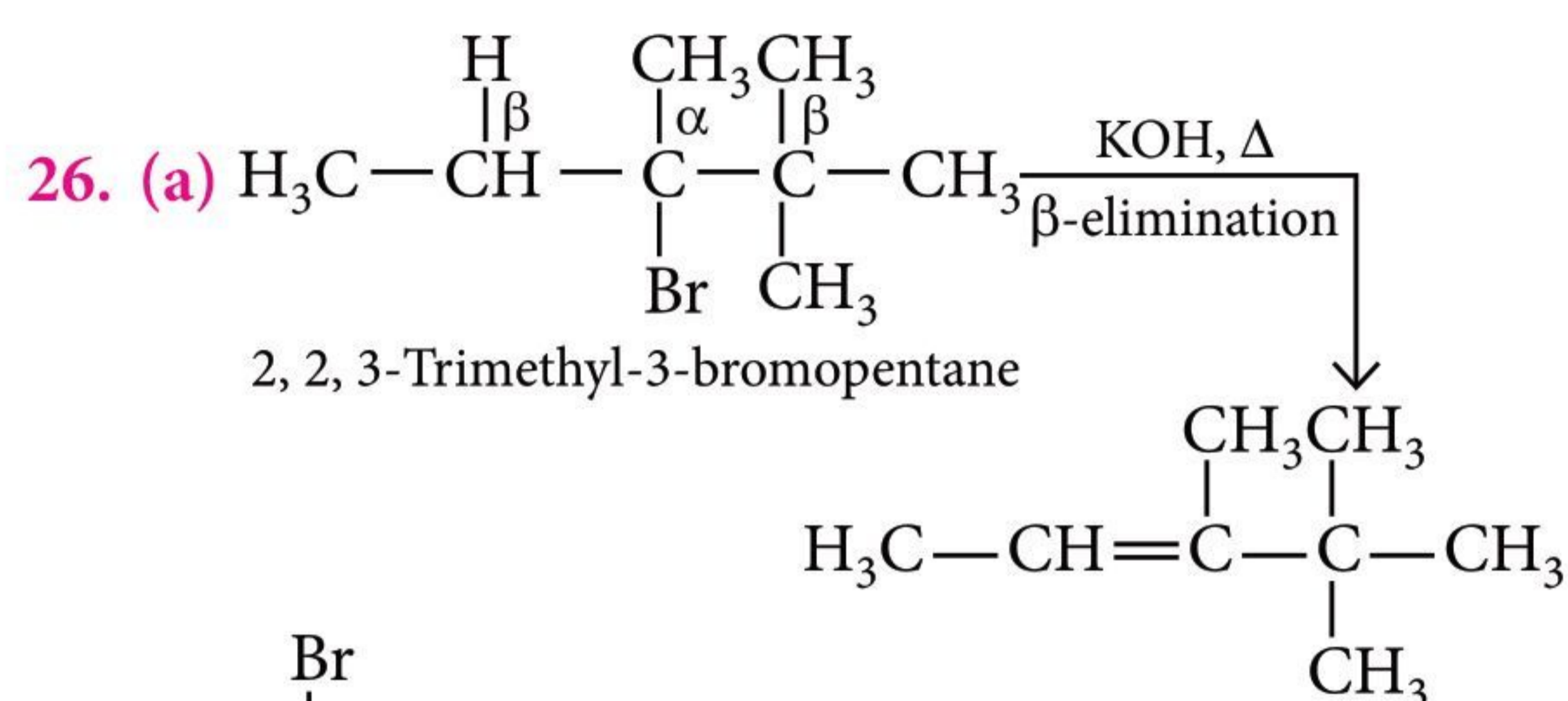
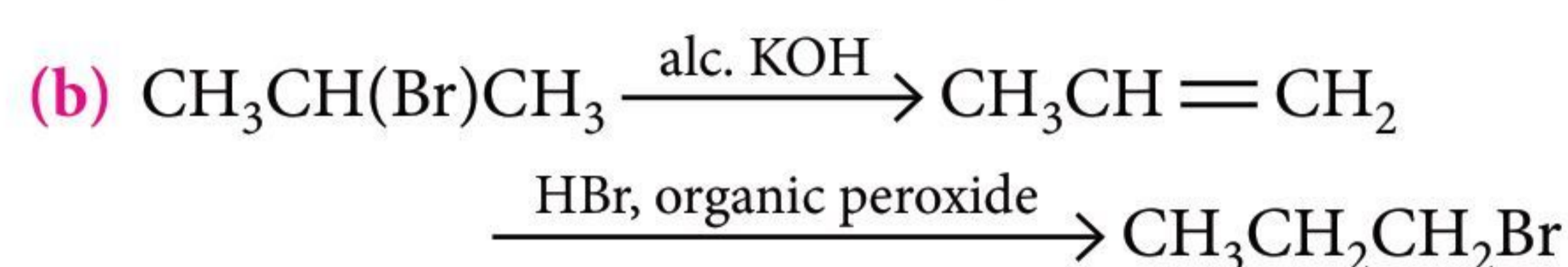
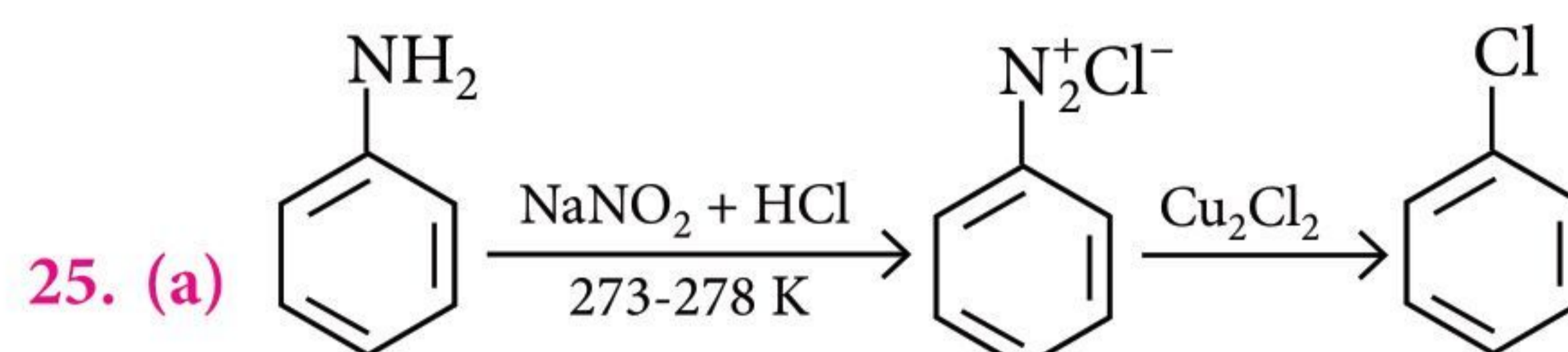
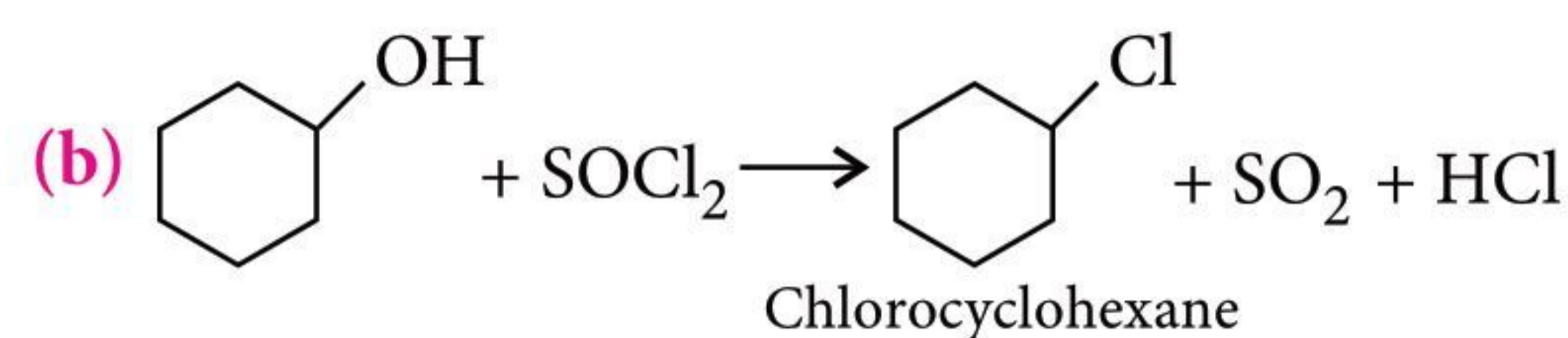
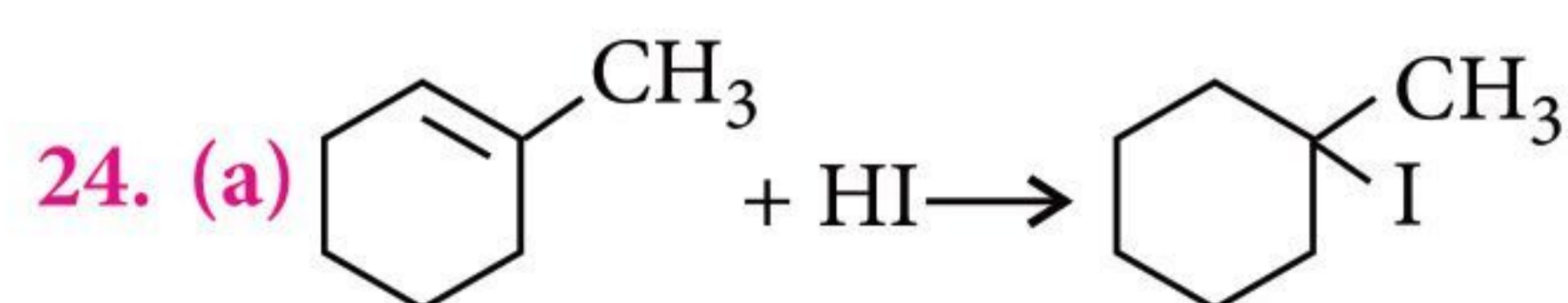
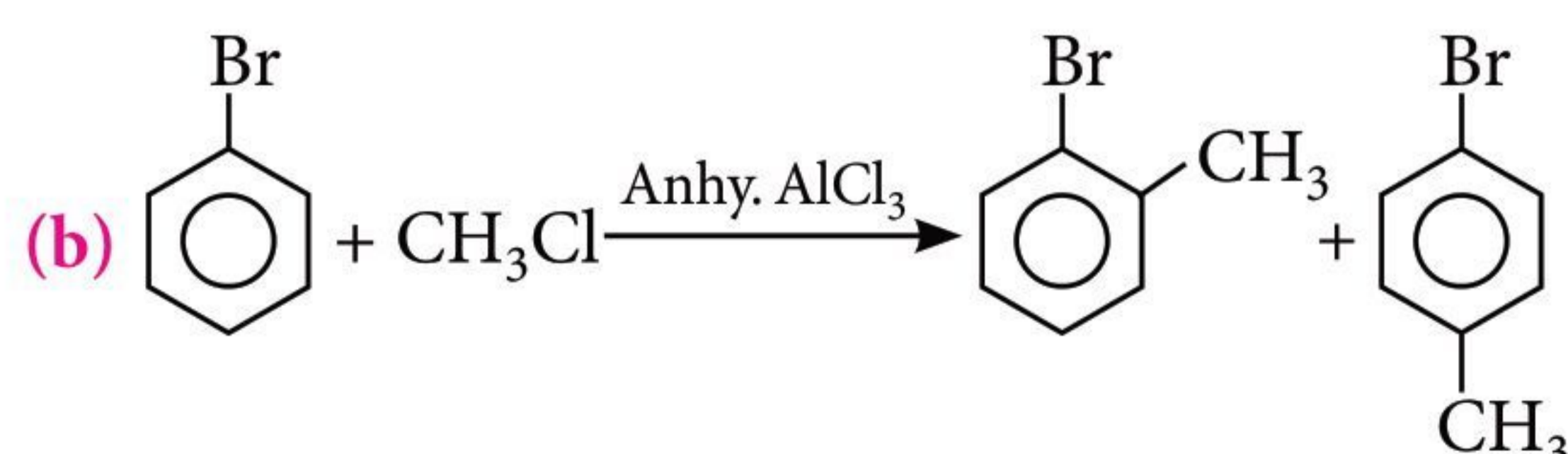
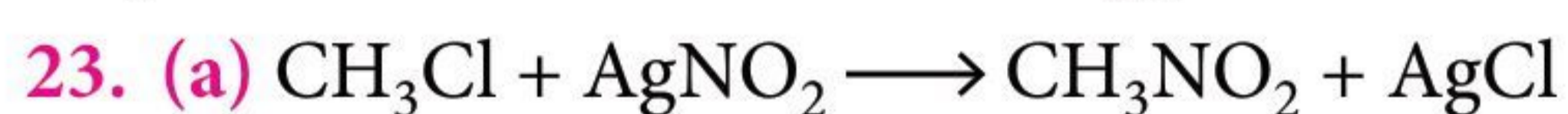
22. (a) When ethyl chloride is treated with aqueous KOH, ethanol is formed,



OR

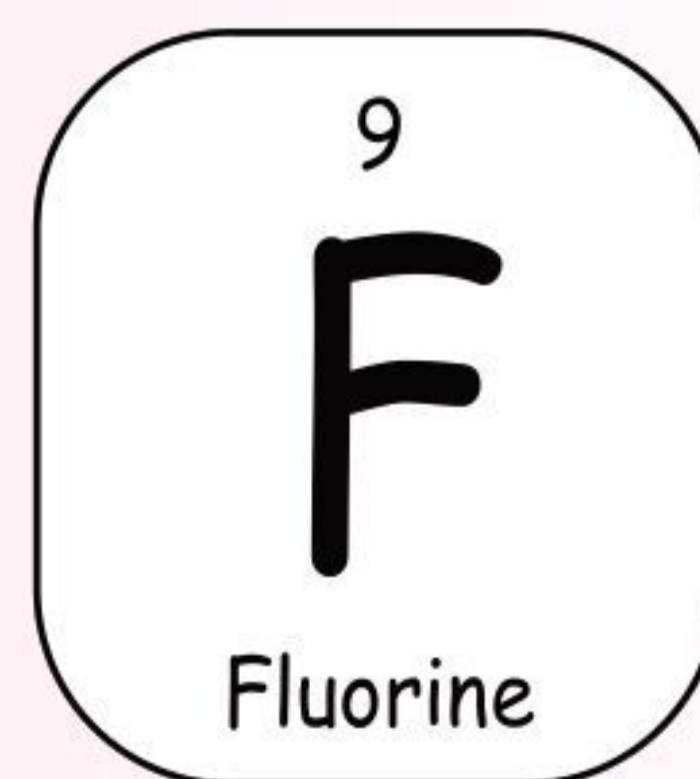
(a) $(\text{CH}_3)_3\text{C}-\text{I}$ is more reactive than $(\text{CH}_3)_3\text{C}-\text{Br}$ because C—I bond has the minimum bond dissociation enthalpy.

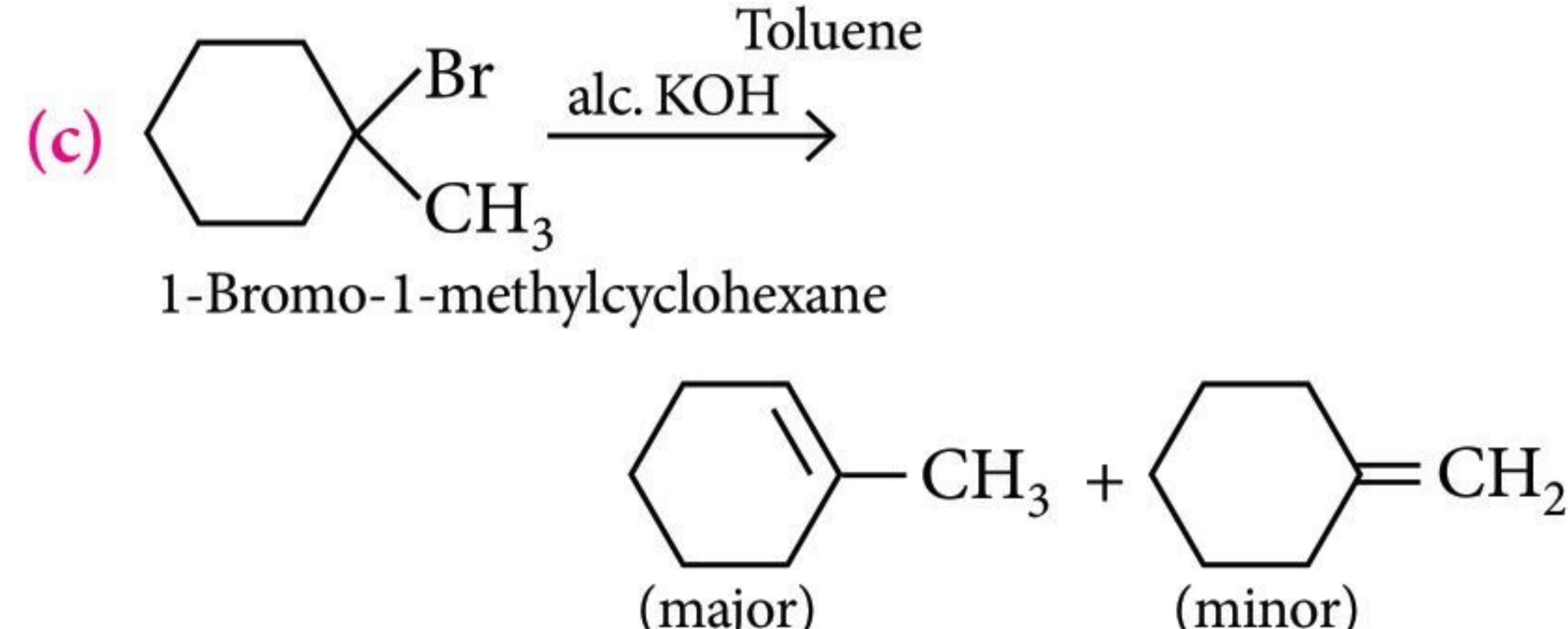
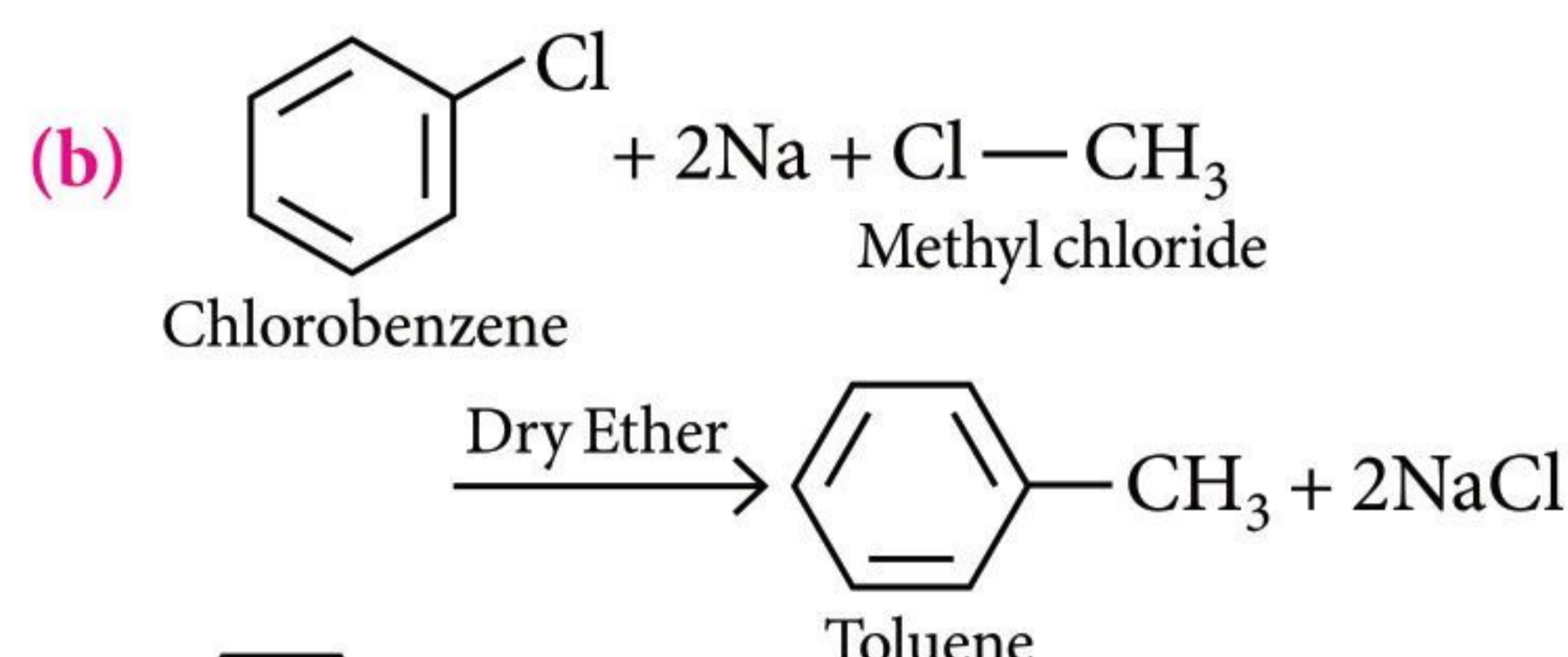
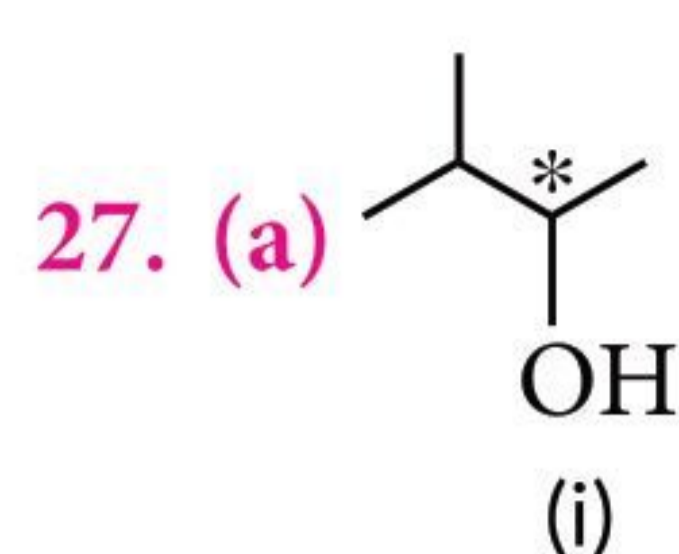
(b) *dextro* and *laevo*-rotatory isomers of butan-2-ol are difficult to separate by fractional distillation because they have almost the same boiling point.



COMIC CAPSULE

Chemistry Is



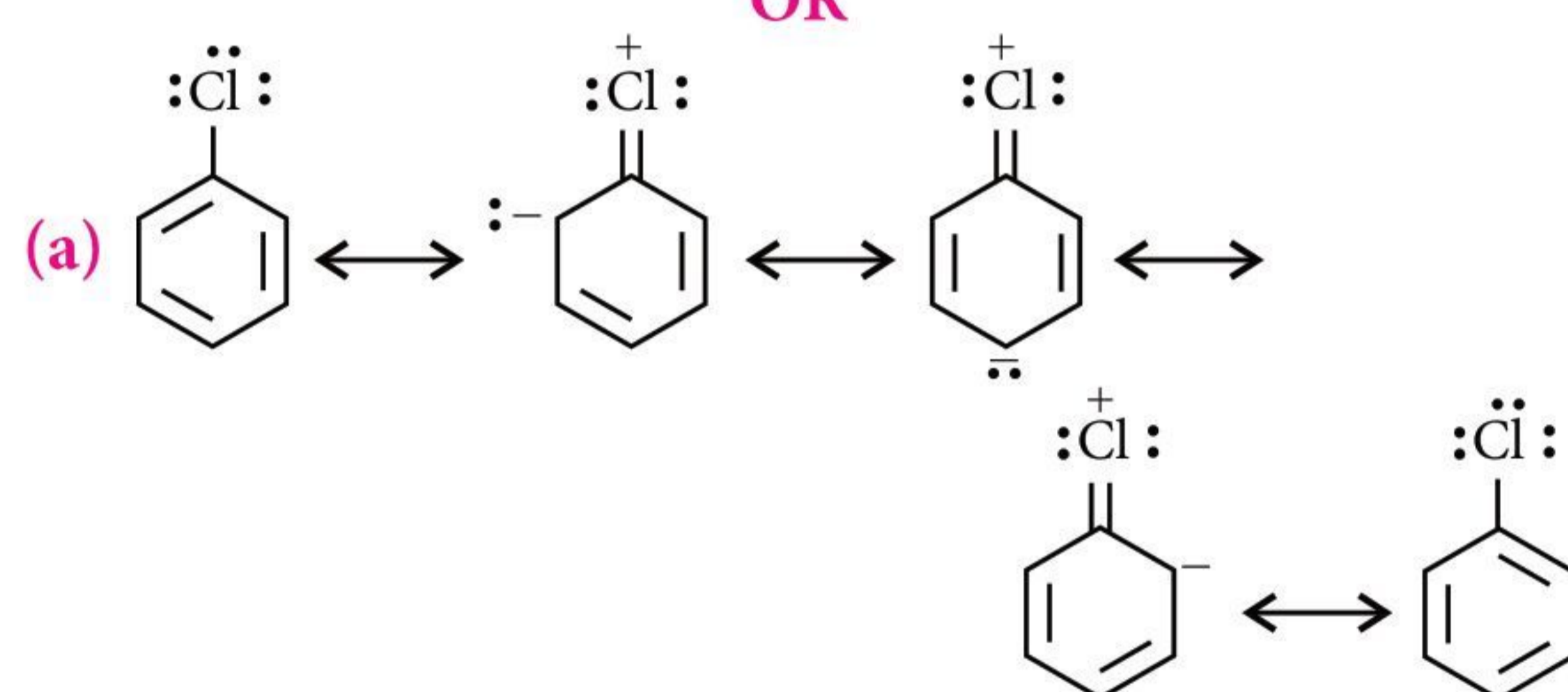


28. (a) 1-Bromopentane

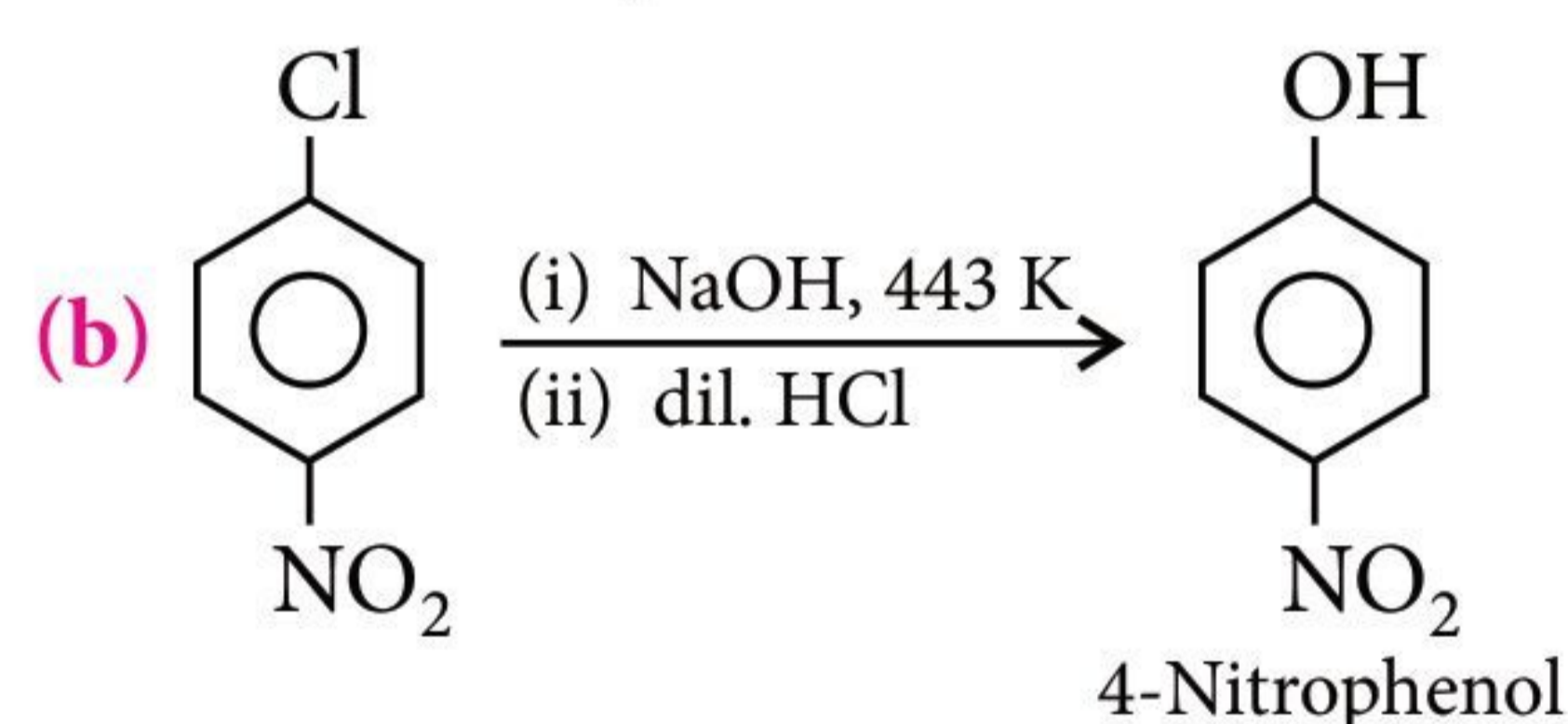
(b) 2-Bromopentane

(c) 2-Bromo-2-methylbutane

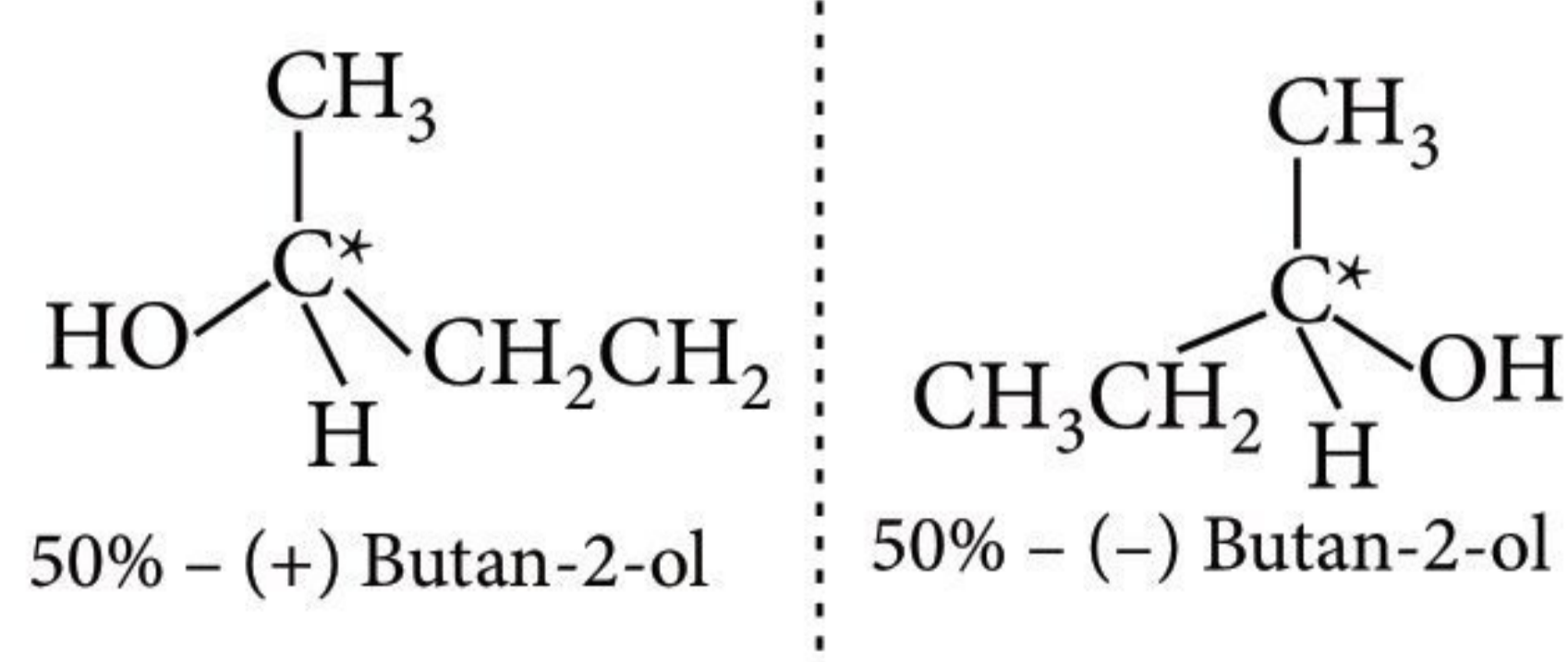
OR



Although $-\text{Cl}$ is an electron withdrawing group ($-I$ effect) but still it is o - and p -directing as due to $+R$ effect, electron density is maximum at o - and p -positions.



(c) (\pm) -Butan-2-ol is optically inactive because the two enantiomeric forms are present in equal amounts and rotate plane of polarized light in opposite direction with equal angle so, the net solution is optically inactive

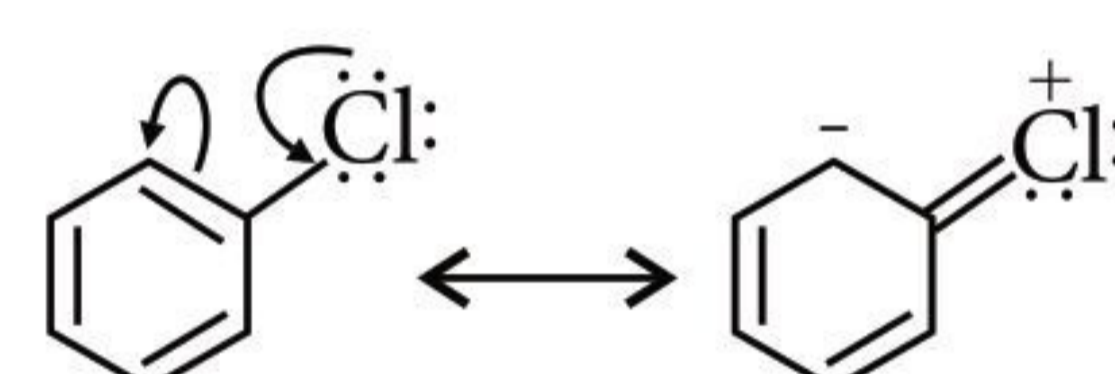


29. (a) 1-Bromobutane is 1° alkyl halide while 2-bromobutane is 2° alkyl halide. Due to steric hindrance in 2° alkyl halides, 1° alkyl halide will react faster than 2° alkyl halide in S_N2 reaction.

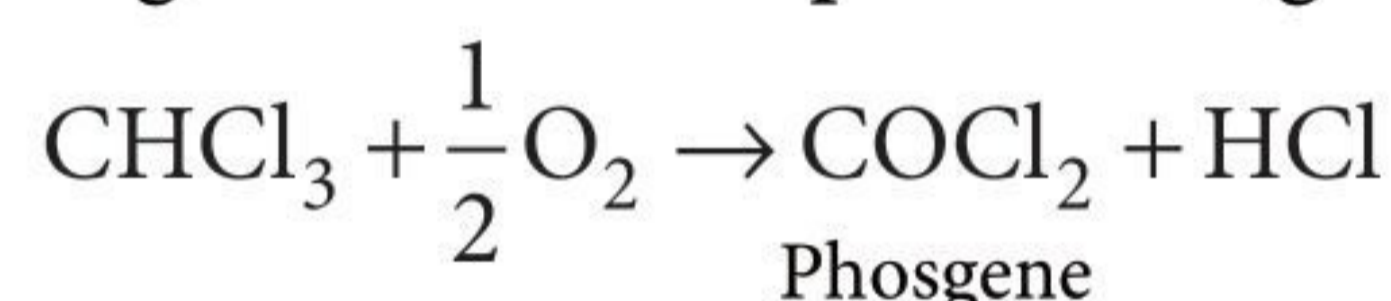
(b) In S_N1 reactions, carbocation intermediate is formed which is a planar molecule so, an incoming nucleophile can attack from either side and a equimolar mixture of two components are formed and resulting mixture is optically inactive.

30. (i) In halobenzene, $\text{C}-\text{X}$ bond has partial double bond character due to resonance while CH_3-X bond is single bond.

Thus, bond length of $\text{C}-\text{X}$ bond in halobenzene is smaller than that in CH_3-X .



(ii) Chloroform when exposed to air and sunlight changes to phosgene which is a poisonous gas.




Thus, it is kept in dark coloured bottles to prevent the oxidation.

(iii) Since I^- is a better leaving group than Br^- , thus, $\text{CH}_3\text{CH}_2\text{I}$ undergoes S_N2 reaction faster than $\text{CH}_3\text{CH}_2\text{Br}$.

(iv) $\text{C}_6\text{H}_5\text{CHClC}_6\text{H}_5$ will be hydrolysed easily due to formation of 2° carbocation which is stabilised through resonance with two benzene ring.

31. (a) Nucleophilic substitution reaction (S_N1) proceeds with racemisation.

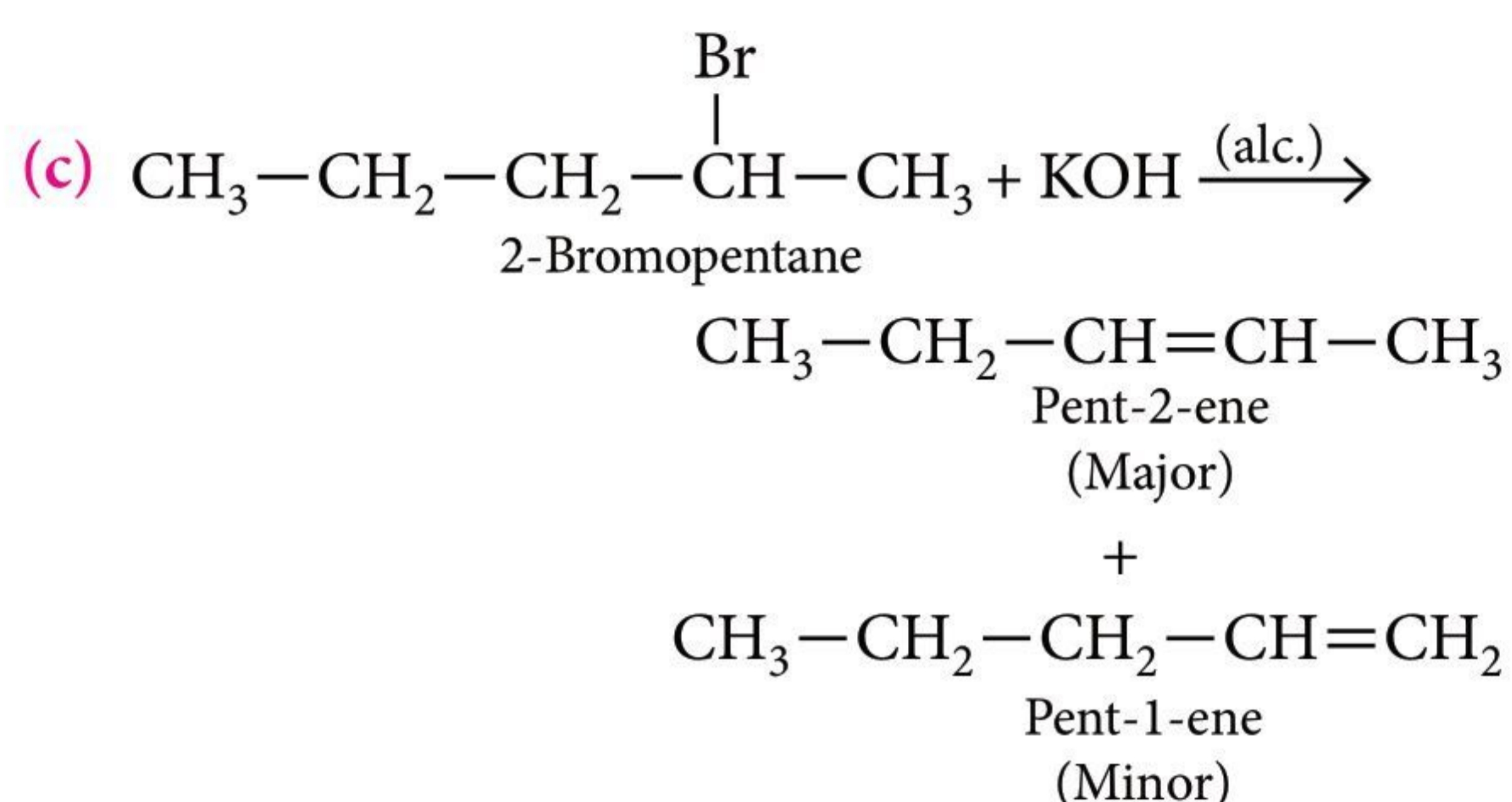
(b) Polarimeter is used for measuring the angle by which the plane polarised light is rotated.

 **Recipe for Success**

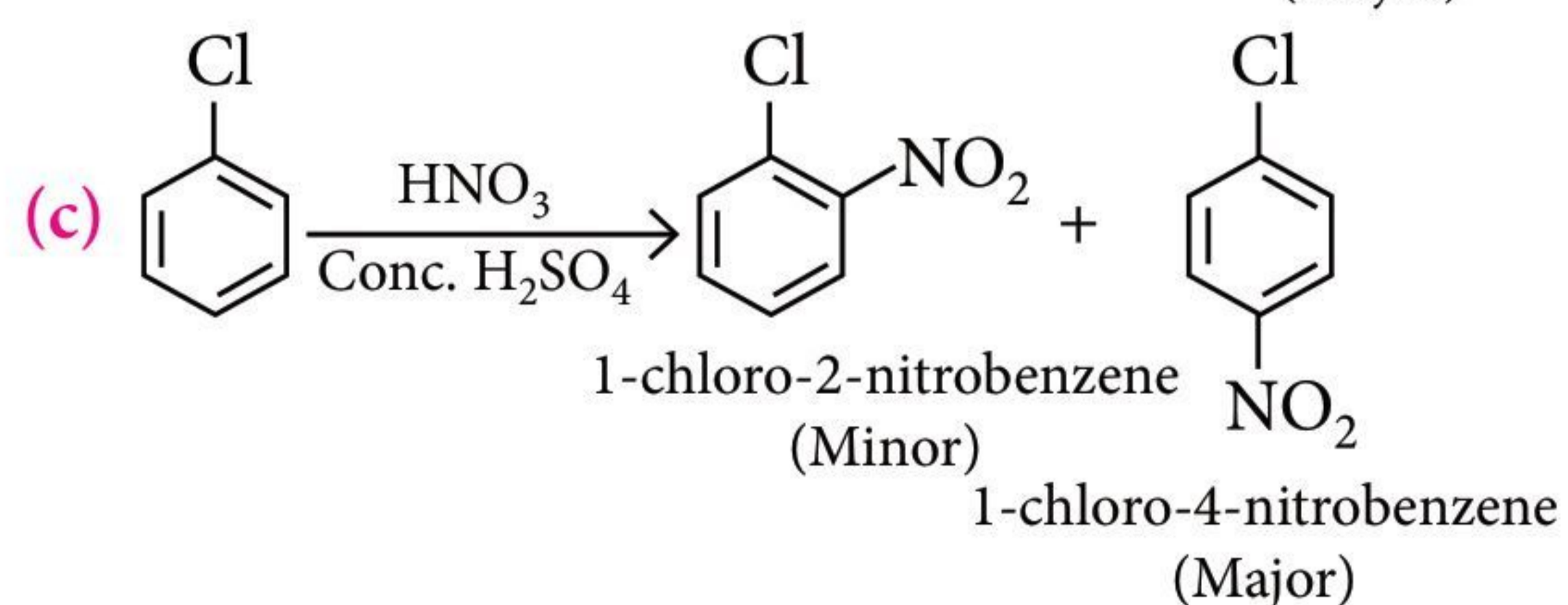
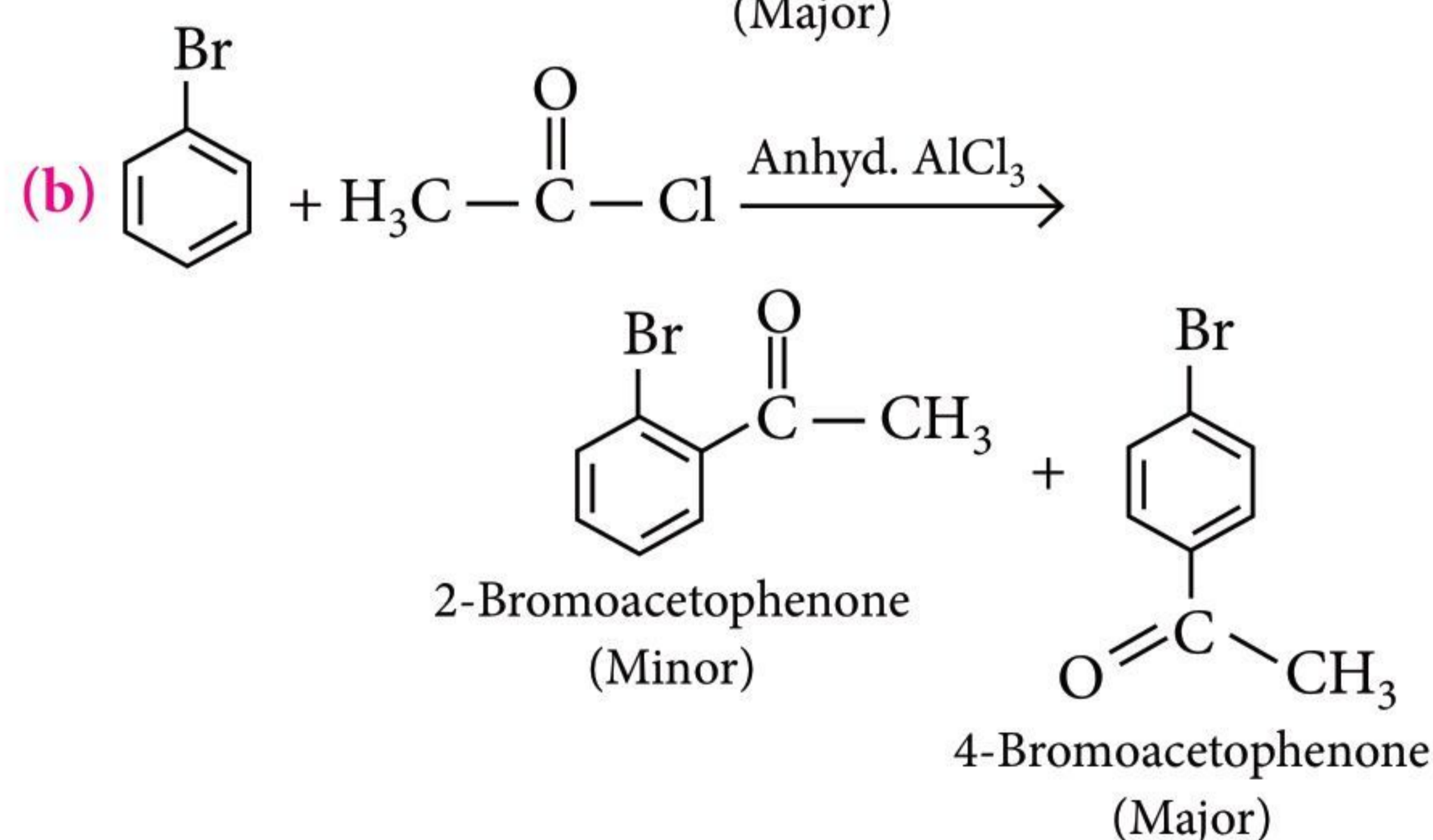
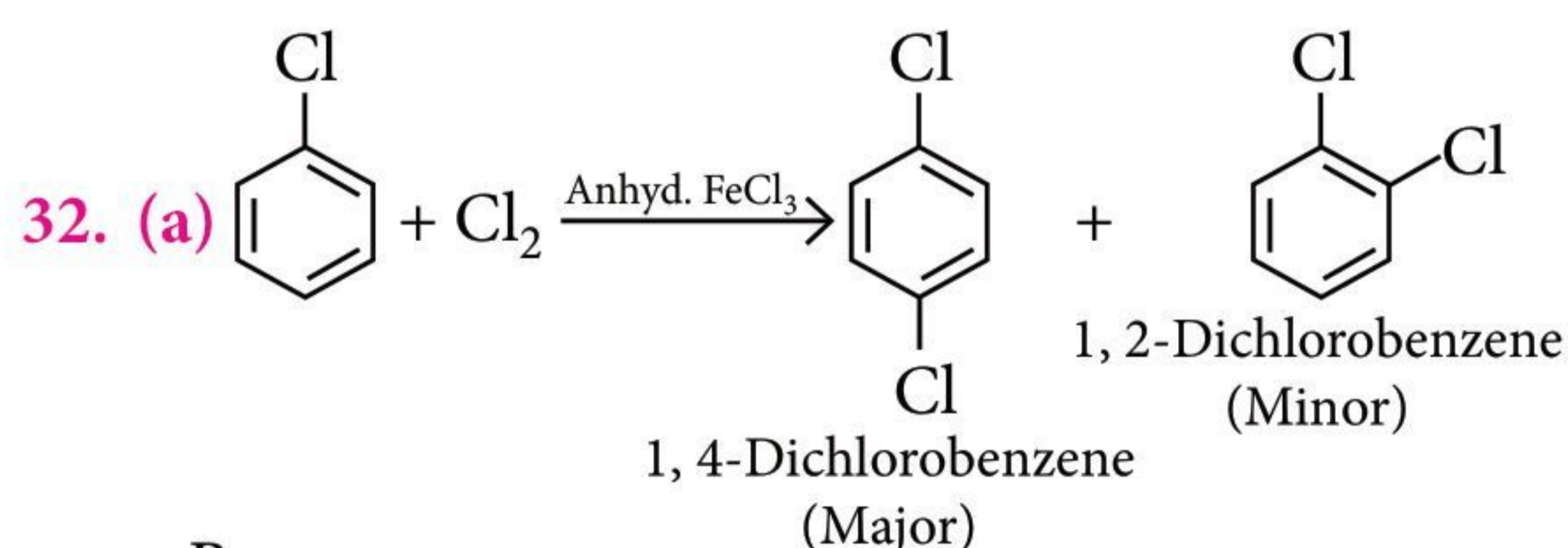
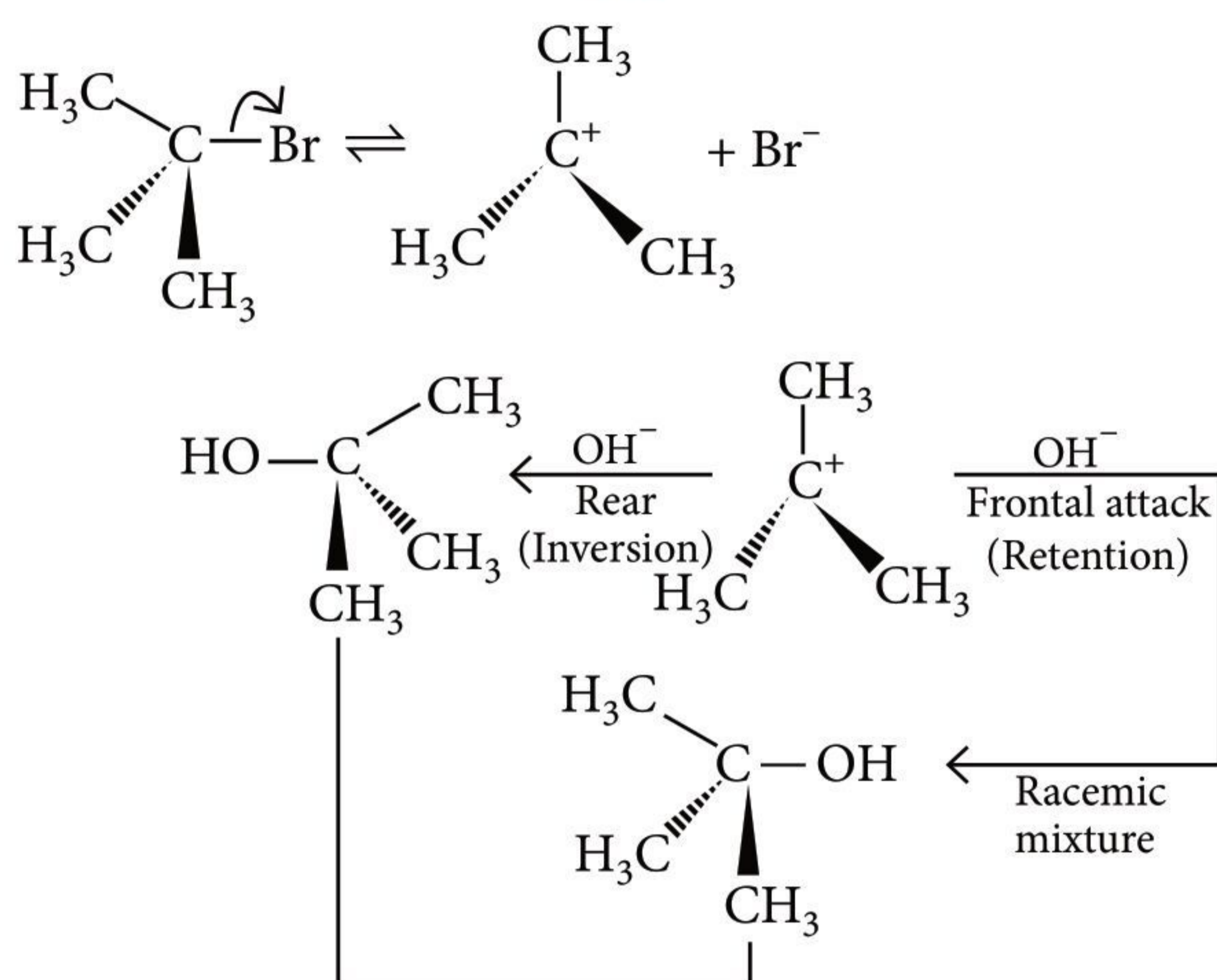
“Perseverance is the hard work you do after you get tired of doing the hard work you already did.”

THE ELEMENTS OF SUCCESS

9 F Fluorine	8 O Oxygen	29 Cu Copper	16 S Sulphur
---------------------------	-------------------------	---------------------------	---------------------------

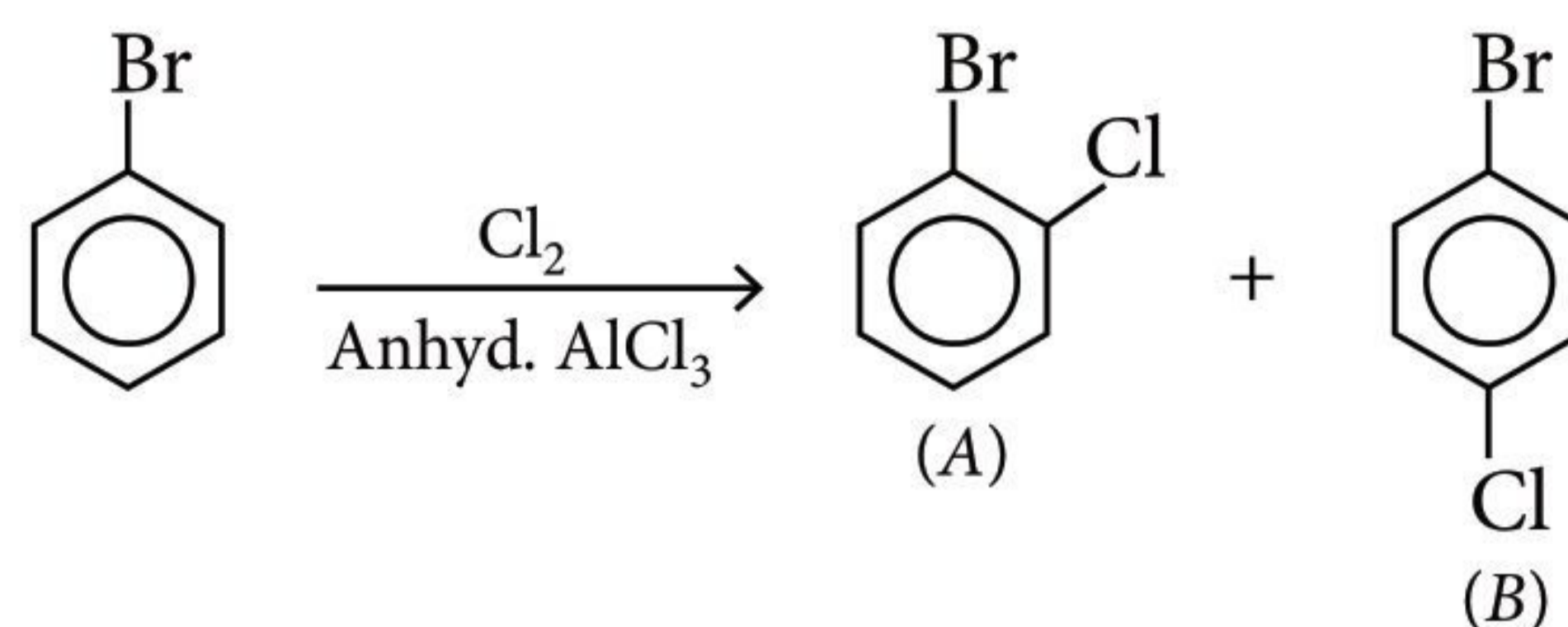


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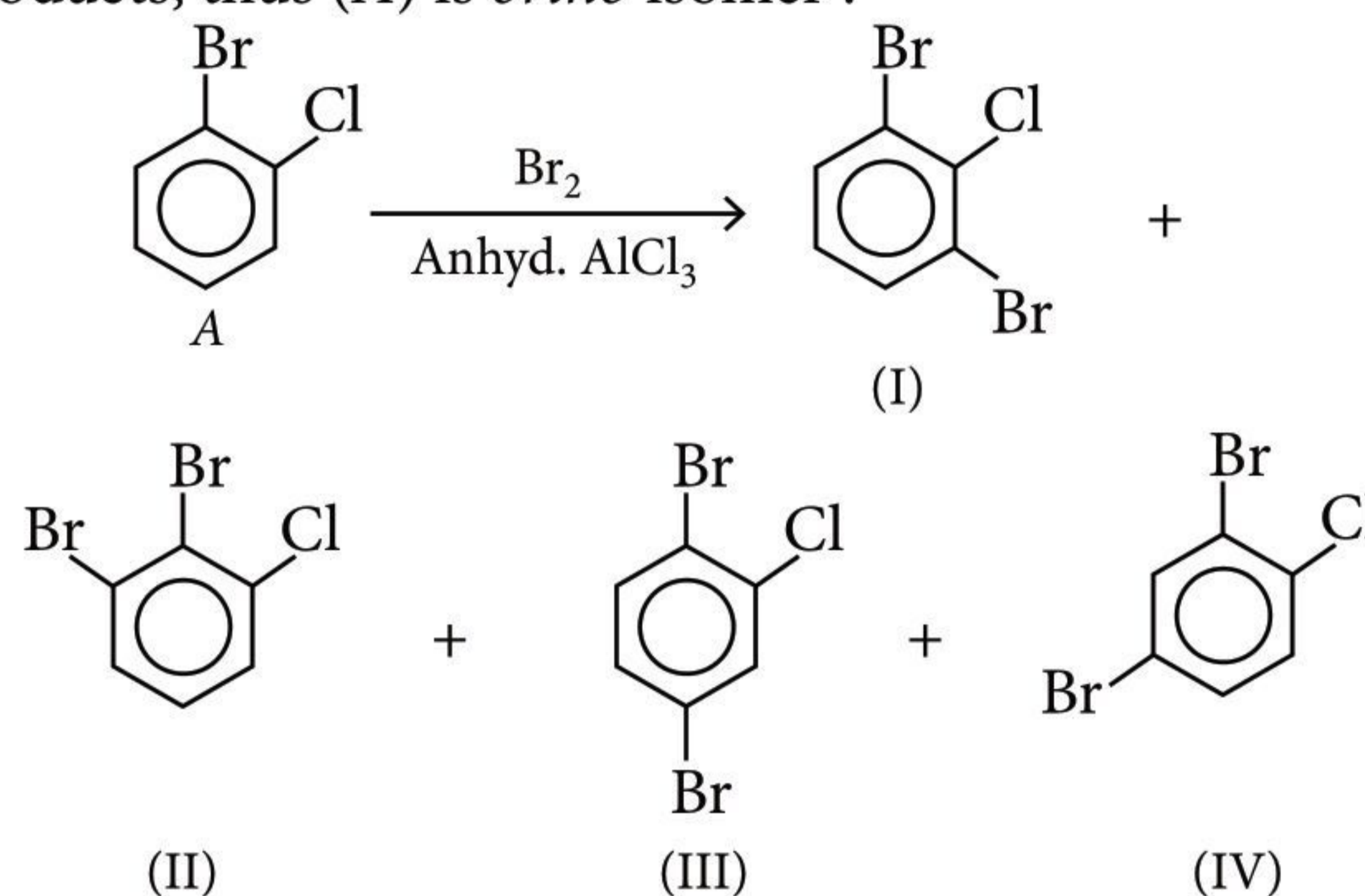


OR

Since bromine is an *o*- and *p*- directing group, on chlorination of bromobenzene the products A and B formed are:

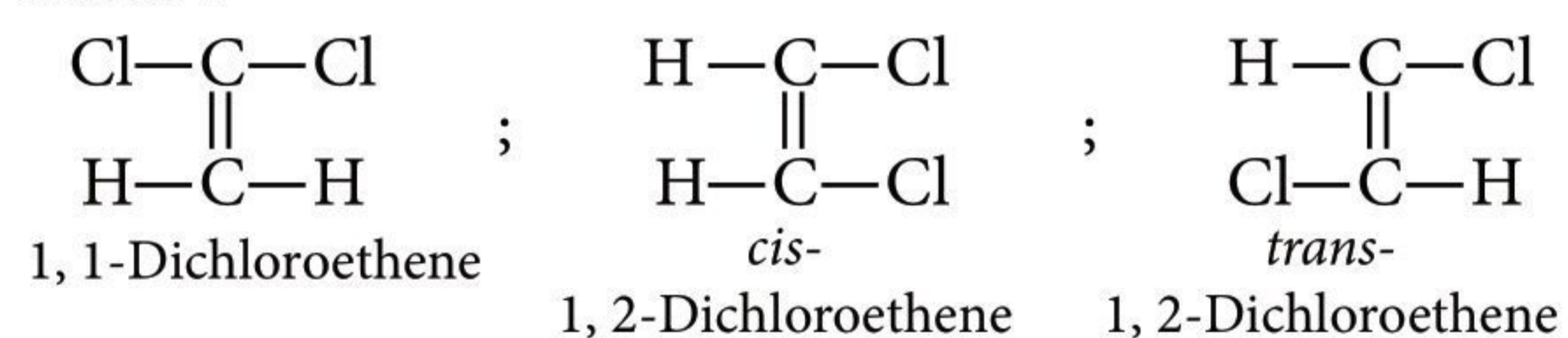


Further, monobromination of (A) gives several products, thus (A) is *ortho* isomer:

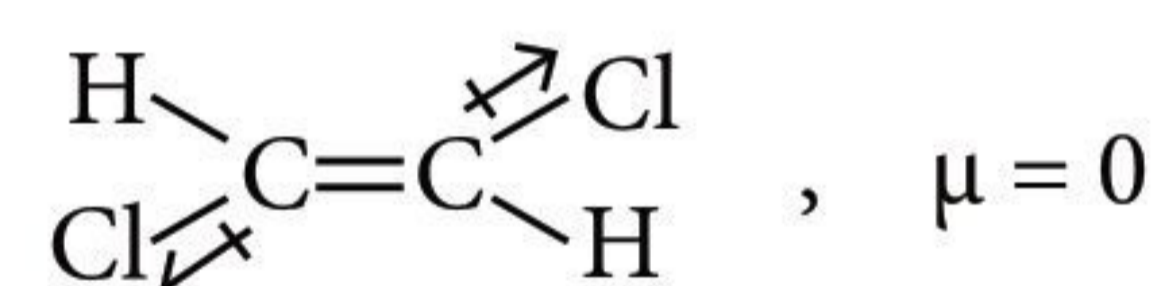


33. (a) Haloalkanes dissolve in organic solvents because the intermolecular attractions between haloalkanes and organic solvent molecules have the same strength as in the separate haloalkanes and solvent molecules.

(b) Dichloroethene exists in following three isomeric forms:



The resultant dipole moment will be zero in case of *trans*-1,2-dichloroethene.



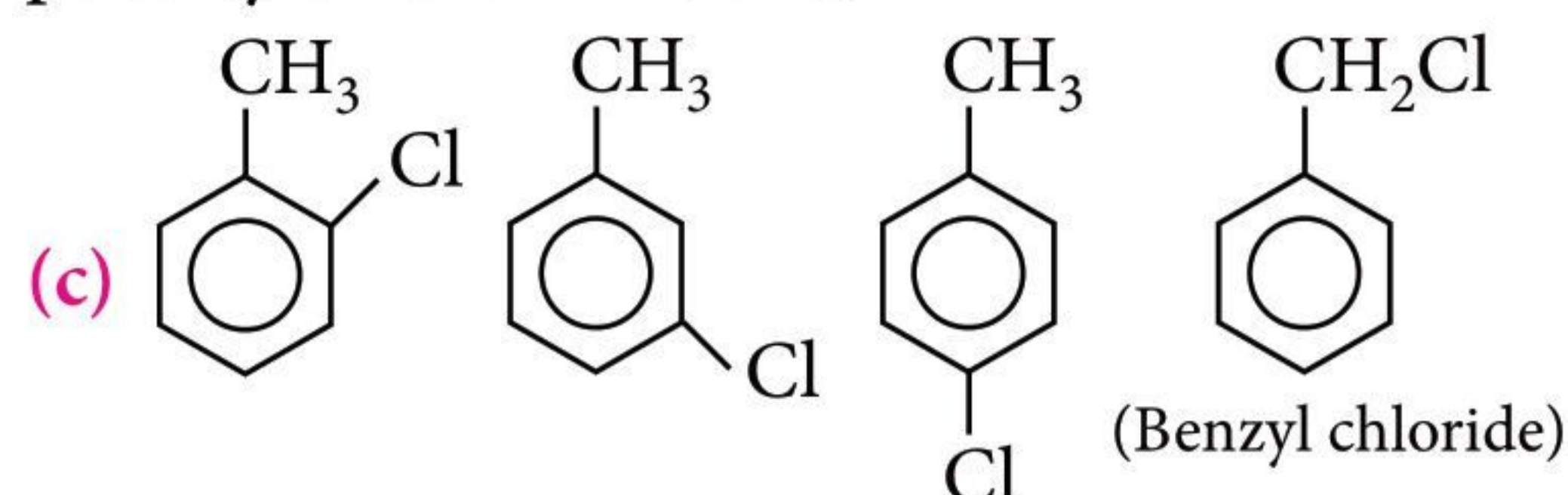
(c) In the given sequence the increase in size (iodine atom being largest) and molecular weights are responsible for greater van der Waals' forces of attraction which overshadows the dipole-dipole attractions.

OR

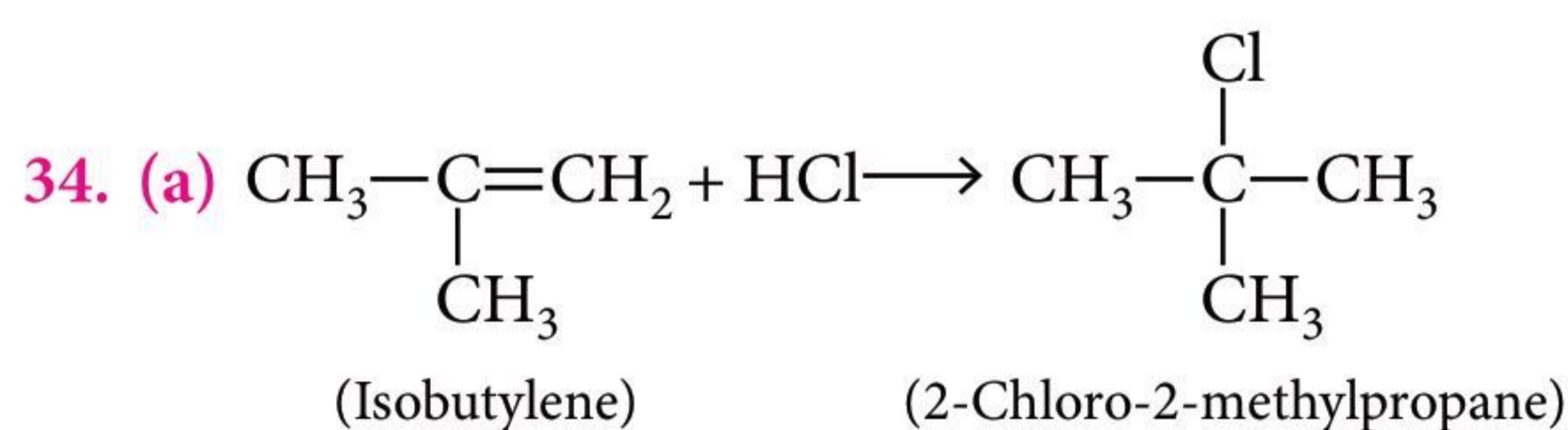
(a) Allyl chloride shows high reactivity as the carbocation formed by hydrolysis is stabilised by resonance while no such stabilisation of carbocation exists in the case of *n*-propyl chloride.

(b) In haloarenes, $-\text{ve}$ charge gets localised on arenes using resonance, therefore they undergo electrophilic substitution.

Haloalkanes have electrophilic carbon centre due to polarity of $C \rightarrow X$ bond.

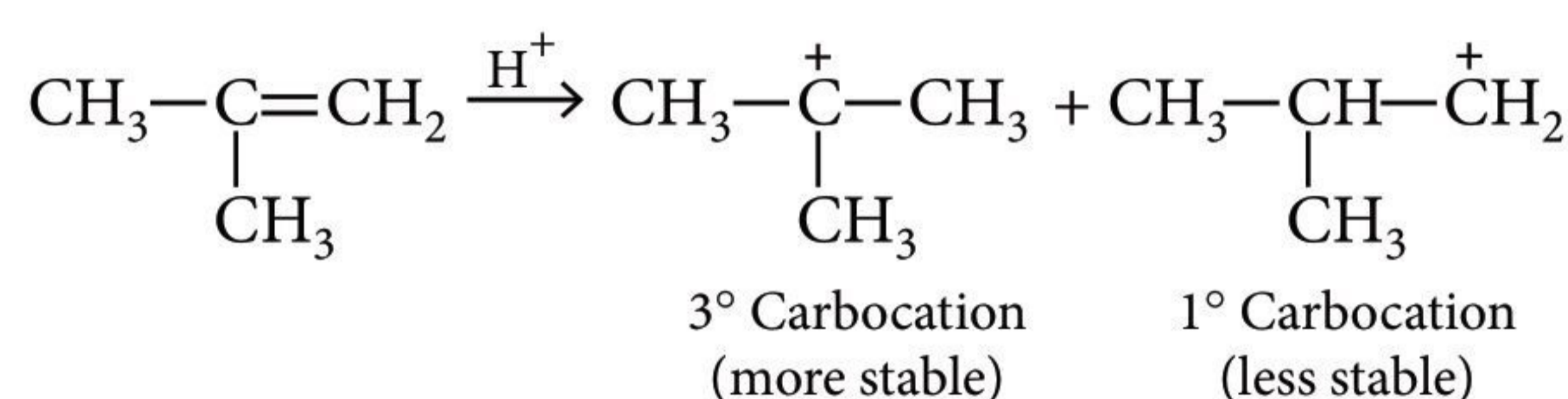


Among these isomers, benzyl chloride has the weakest $C-Cl$ bond. Because in all other isomers $C-Cl$ bond has some double bond character due to resonance.

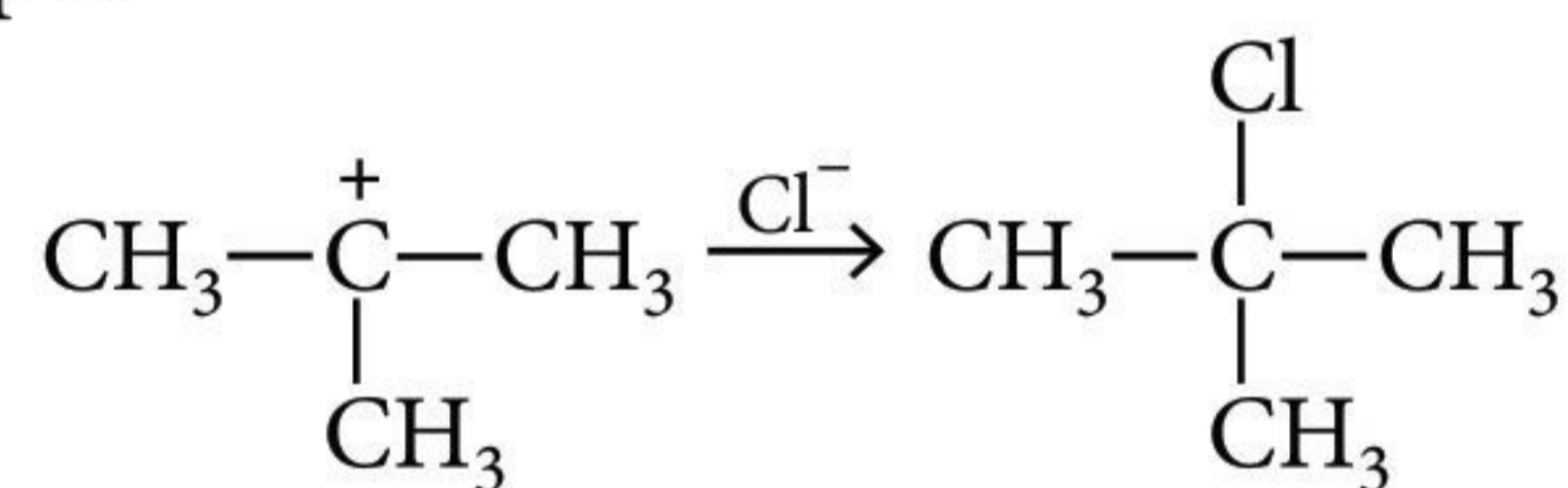


Mechanism :

Step-I



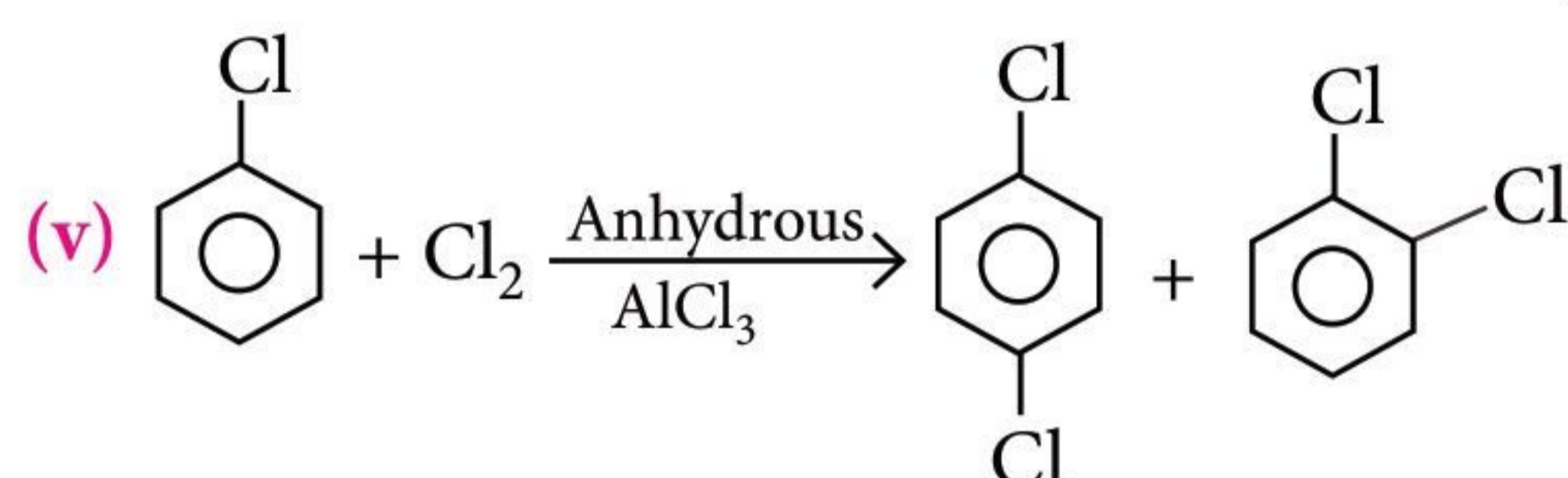
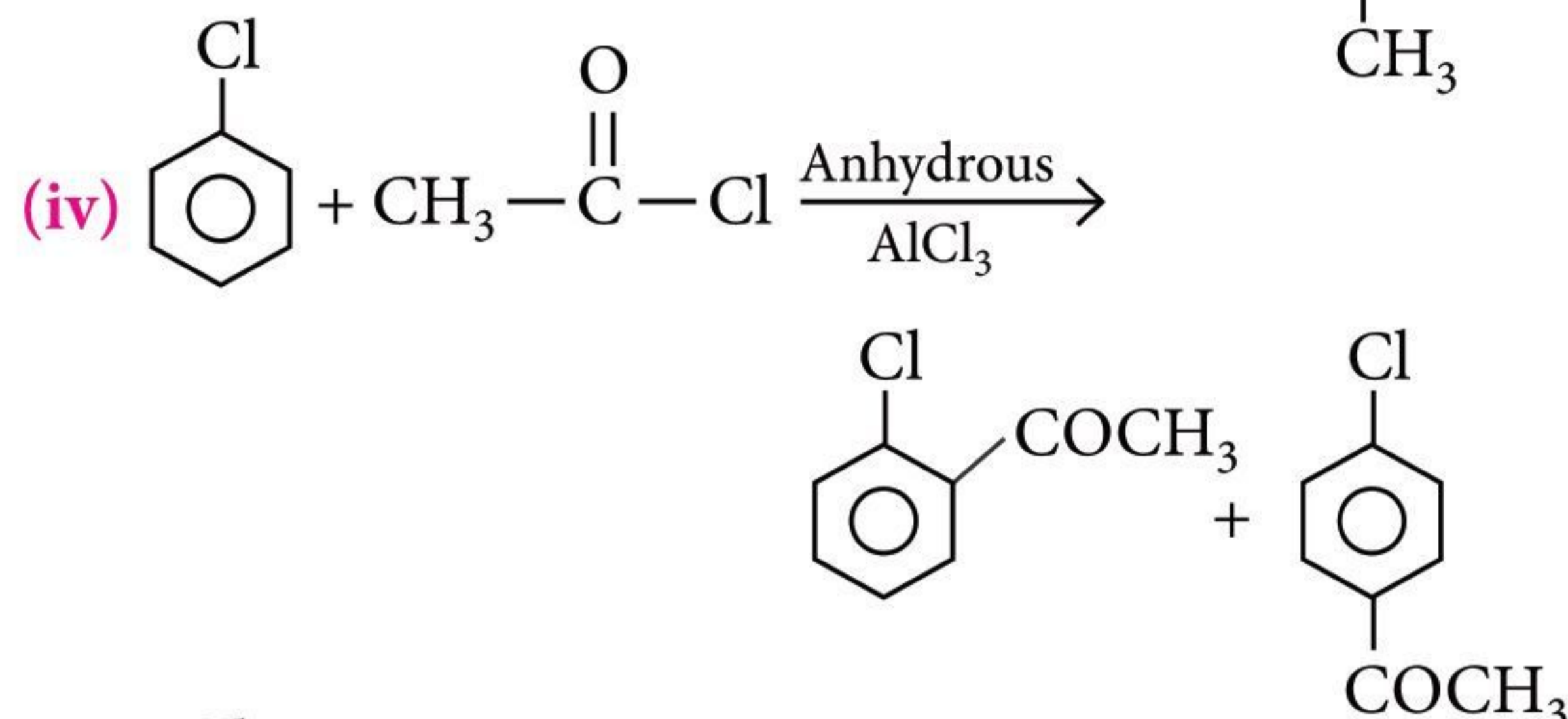
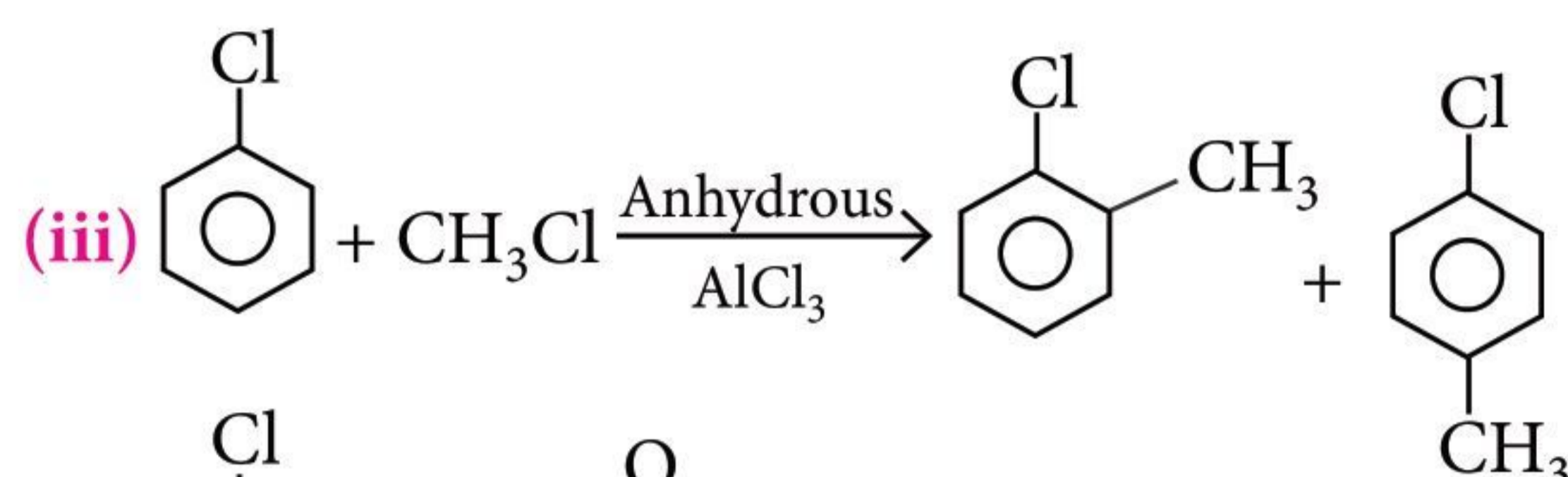
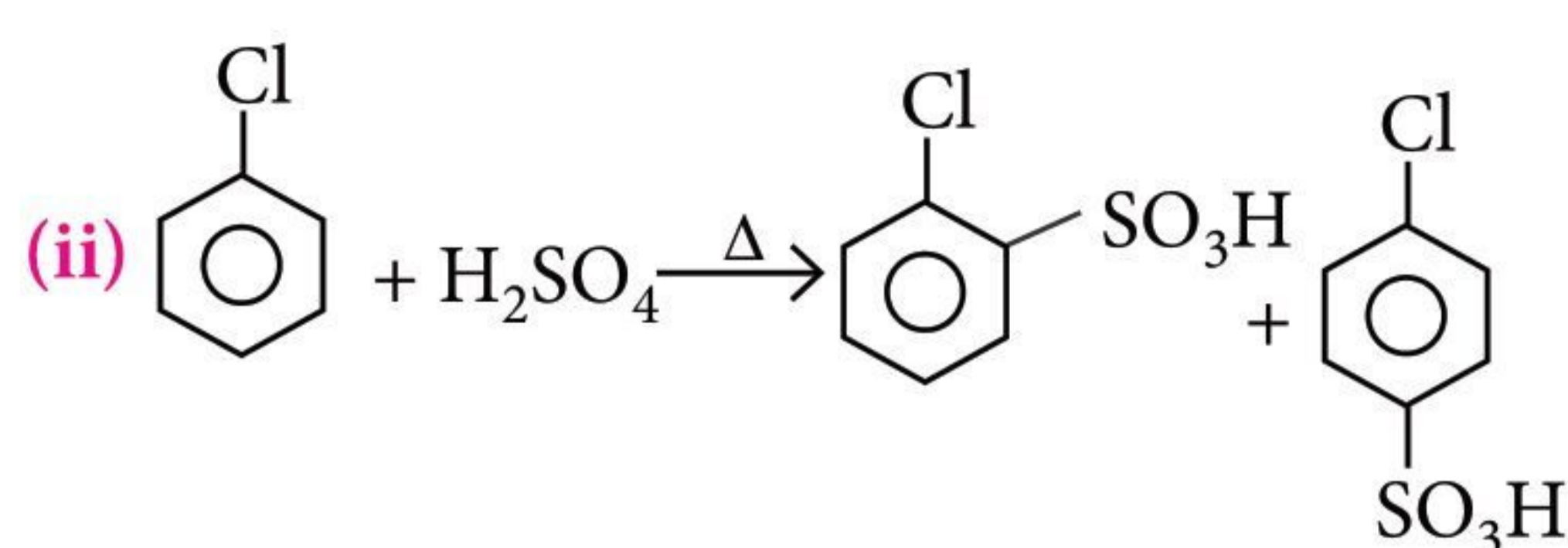
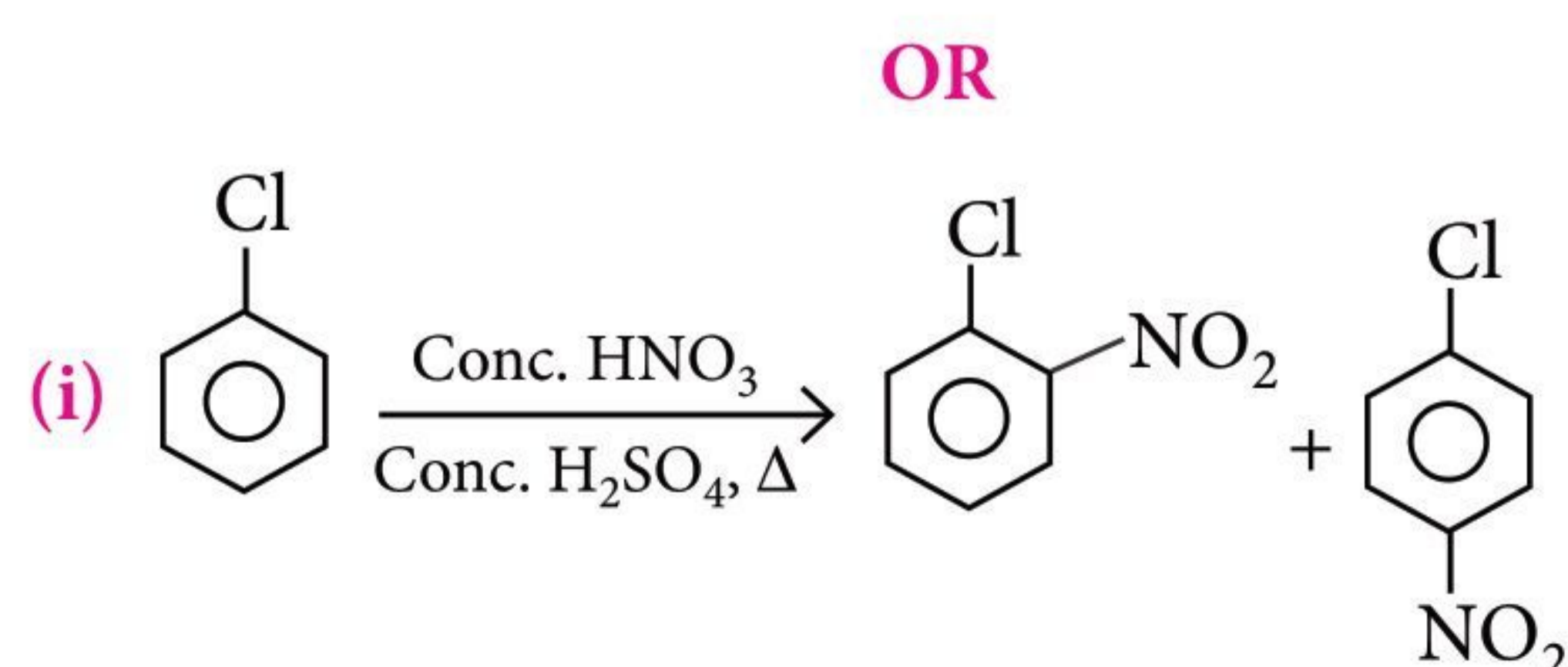
Step II



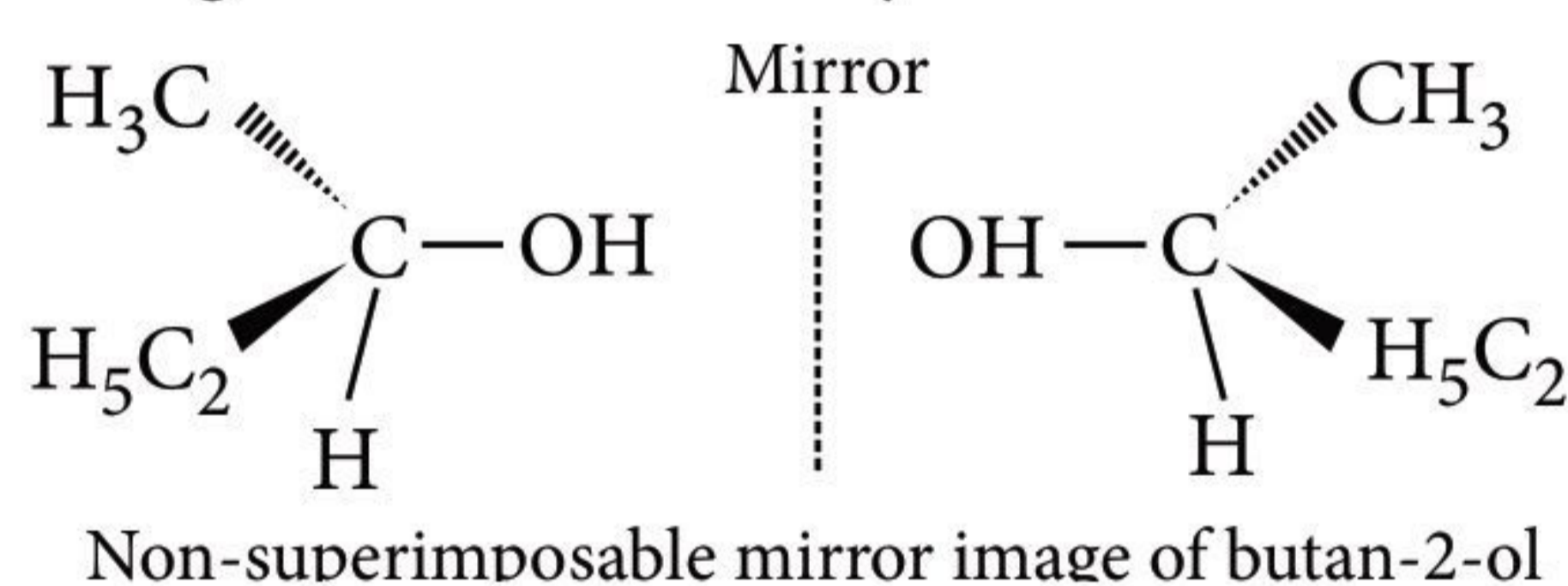
(b) $C \equiv N^-$ acts as a stronger nucleophile from carbon end because it will lead to the formation of $C-C$ bond which is more stable than $C-N$ bond if linkage is from N side.

(c) Free radical halogenation of alkanes is not a suitable method to obtain an alkyl halide because :



- It gives a mixture of isomeric monohalogenated products whose boiling points are so close that their separation is difficult.
- Polyhalogenation may also occur making the product mixture more complex and hence, difficult to separate.



35 (a) The molecules which are not superimposable on their mirror images are called chiral molecules. The property of non-superimposability of a structure on its mirror image is called chirality.



(b) $CH_3CH_2CH(Cl)CH_3$ hydrolyses easily with KOH because it is a secondary halide.

(c) As iodide is a better leaving group because of its large size, therefore,  undergoes S_N2 reaction faster than .





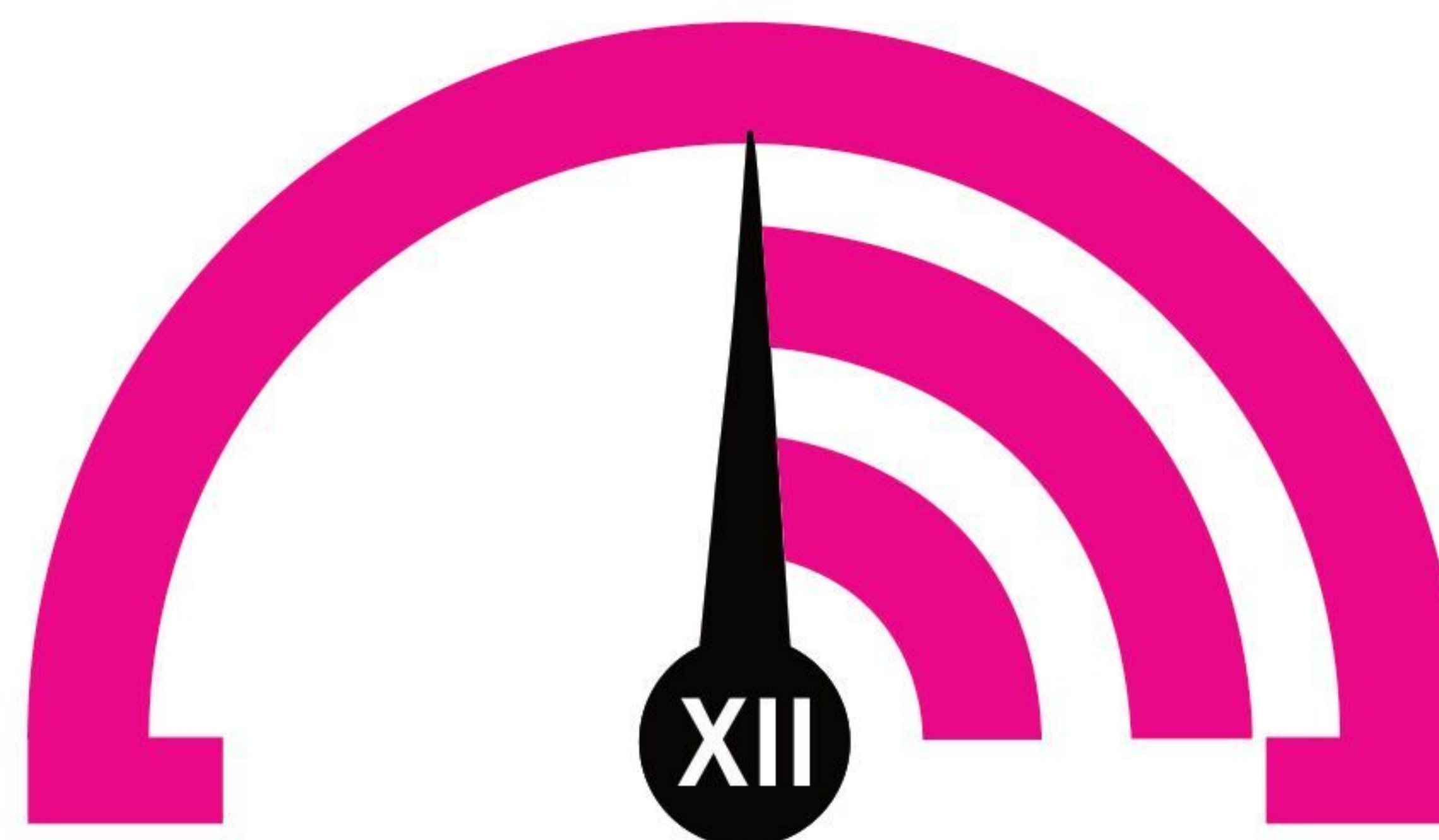
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Total Marks : 120

General Principles and Processes of Isolation of Elements | Chemistry in Everyday life

Time Taken : 60 Min.

NEET

Only One Option Correct Type

- Which of the following statements is not correct?
(a) Soaps act by lowering surface tension between water and oil or insoluble material.
(b) Soap forms insoluble salt with Ca^{2+} ions.
(c) The COO^- group in soaps acts as hydrophilic and alkyl chain as hydrophobic.
(d) Soaps work more efficiently in hard water than in soft water.
- Which one is malachite from the following?
(a) $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ (b) CuFeS_2
(c) $\text{Cu}(\text{OH})_2$ (d) Fe_3O_4
- Which of the following is used as a sedative?
(a) Paracetamol (b) Chloroquine
(c) Bithionol
(d) Barbituric acid derivatives
- Sodium cyanide is added as a depressant in the froth floatation process when the ore contains a mixture of ZnS and PbS . This is done so that
(a) $\text{Pb}(\text{CN})_2$ gets precipitated without any effect on ZnS
(b) ZnS forms soluble complex while PbS forms froth
(c) PbS forms soluble complex while ZnS forms froth
(d) $\text{Zn}(\text{CN})_2$ gets precipitated without any effect on PbS .
- Among the following compounds, the only one which is not an artificial sweetening agent is
(a) aspartame (b) sucrose
(c) sucralose (d) saccharin.
- When limestone is heated, CO_2 is given off. The metallurgical operation is
(a) smelting (b) reduction
(c) calcination (d) roasting.
- Bithionol is an example of
(a) disinfectant (b) antiseptic
(c) antibiotic (d) analgesic.
- Slag formed in blast furnace, removes the impurity of
(a) SiO_2 (b) CaO (c) CO_2 (d) FeO
- Mixture of chloroxylenol and terpineol acts as
(a) antiseptic (b) antipyretic
(c) antibiotic (d) analgesic.
- Bauxite ore is made up of Al_2O_3 , SiO_2 , TiO_2 and Fe_2O_3 . This ore is treated with conc. NaOH solution at 500 K and 35 bar pressure for few hours and filtered hot. In the filtrate, the species present is/are
(a) $\text{Na}[\text{Al}(\text{OH})_4]$ only
(b) $\text{Na}_2[\text{Ti}(\text{OH})_6]$ only
(c) both $\text{Na}[\text{Al}(\text{OH})_4]$ and Na_2SiO_3
(d) Na_2SiO_3 only.
- Which of the following is added to soaps for transparency?
(a) Benzene (b) Ethyl chloride
(c) Ethanol (d) Barbituric acid
- Which of the following involves both calcination and carbon reduction processes to obtain metal from its ore?
(a) Zinc from zinc carbonate
(b) Calcium from calcium carbonate
(c) Copper from copper sulphide
(d) None of these

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
- (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) If assertion is true but reason is false.
- (d) If both assertion and reason are false.

13. Assertion : Sodium dodecylbenzenesulphonate is a biodegradable detergent.

Reason : Detergents having highly branched chains are biodegradable.

14. Assertion : Al cannot reduce MgO below 1500°C while Al can reduce MgO above 1500°C.

Reason : Mg is a liquid at less than 1500°C and gas above 1500°C.

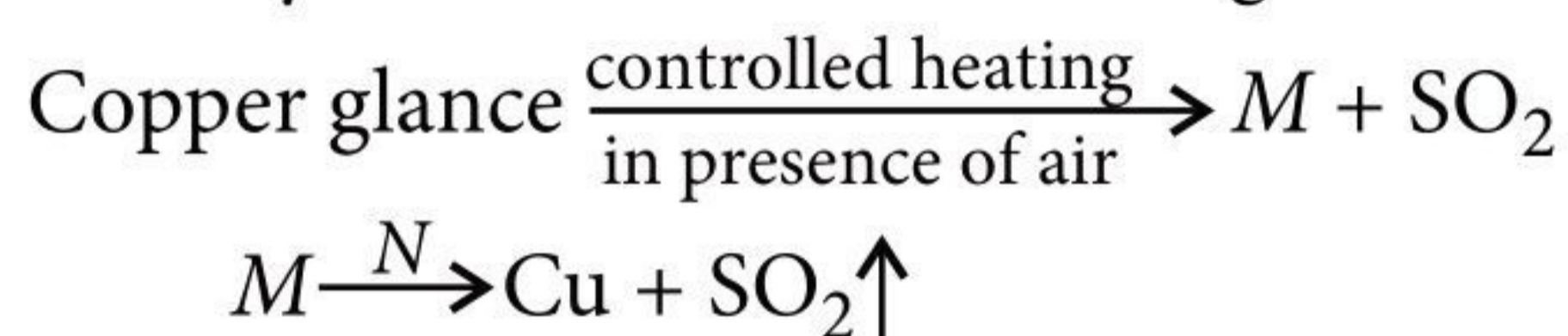
15. Assertion : Cimetidine is an antacid.

Reason : Antacid increases secretion of HCl from gastric cells.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. Identify *M* and *N* in the following reaction.



- (a) $M = \text{Cu}_2\text{O}$; $N = \text{Self reduction}$
- (b) $M = \text{Cu}_2\text{O} + \text{Cu}_2\text{S}$; $N = \text{Only heating}$
- (c) $M = \text{Cu}_2\text{O}$; $N = \text{Carbon reduction}$
- (d) $M = \text{Cu}_2\text{O}$; $N = \text{Electrolytic reduction}$

17. Which of the following is not a true statement about detergents?

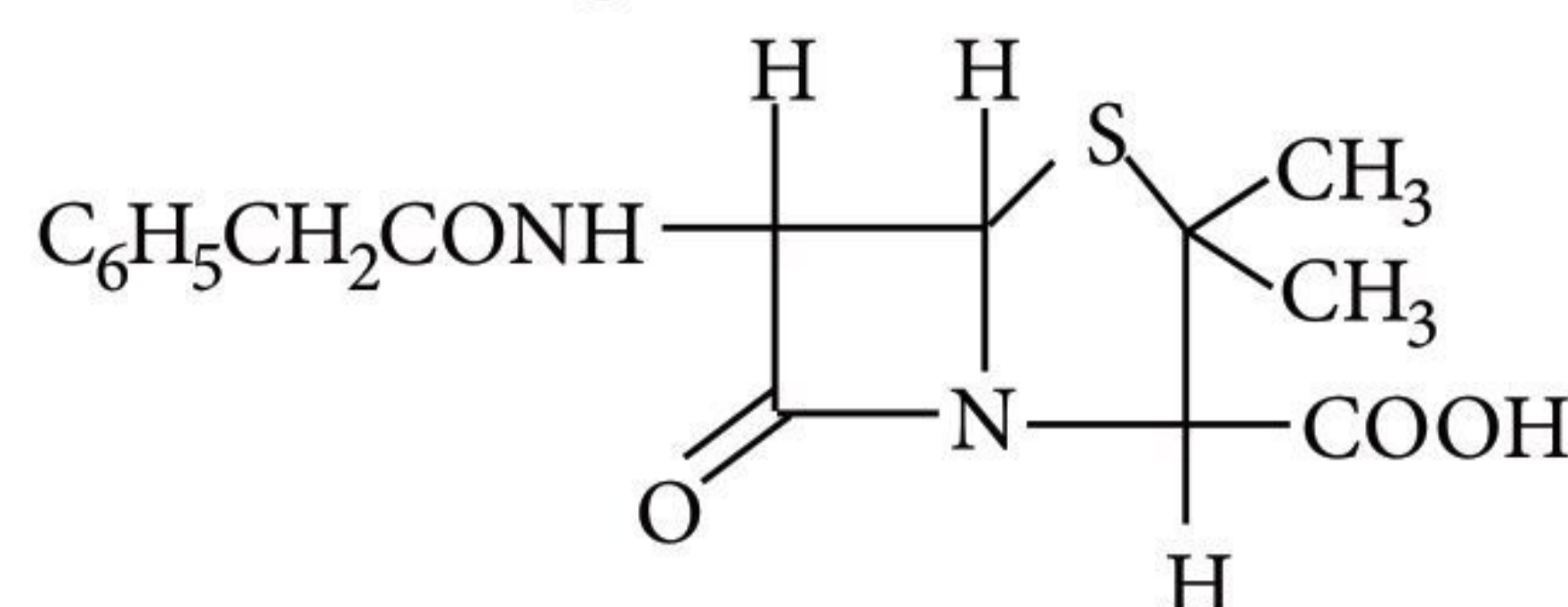
- (a) Anionic detergents are sodium salts of sulphonated long chain alcohols or hydrocarbons.
- (b) Cationic detergents are quaternary ammonium salts of amines with acetates, chlorides or bromides as ions.
- (c) Non-ionic detergents do not contain any ion in their constitution.
- (d) Detergents containing branched hydrocarbon chains are biodegradable.

18. In the extraction of copper, the copper matte is a mixture of

- (a) copper(II) sulphide and iron(II) sulphide
- (b) copper(II) sulphide and iron(III) sulphide

- (c) copper(I) sulphide and iron(II) sulphide
- (d) copper(I) sulphide and iron(III) sulphide.

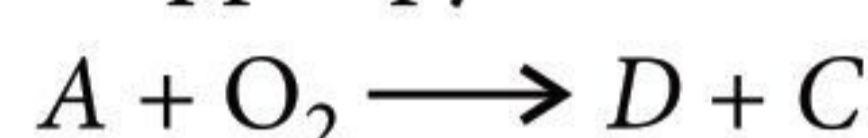
19. The structure given below is known as



- (a) penicillin F
- (b) penicillin G
- (c) penicillin K
- (d) ampicillin.

More than One Option Correct Type

20. Consider the following steps :



Which of the following statements are correct?

- (a) *A* is Cu_2S and *B* is FeS .
- (b) *A* is Cu_2S and *B* is FeO .
- (c) *C* is SO_2 .
- (d) *D* is FeO .

21. Which of the following statements are correct?

- (a) Some disinfectants can be used as antiseptic at low concentration.
- (b) Aspirin is analgesic and antipyretic.
- (c) Norethindrone is an antihistamine.
- (d) Chloramphenicol is a broad spectrum antibiotic.

TRIO

The same THREE LETTERS will complete these five words.

Can you find the three-letter sequence?

TH — — — O S T A T

I S O T H — — —

TH — — — O M E T E R

G — — — A N I U M

E X O T H — — — I C

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22. During the production of iron and steel,
- the oxide ore is primarily reduced to iron by solid coke according to the reaction,

$$2\text{Fe}_2\text{O}_3 + 3\text{C} \longrightarrow 4\text{Fe} + 3\text{CO}_2$$
 - the oxide ore is reduced by the carbon monoxide according to the reaction,

$$\text{Fe}_2\text{O}_3 + 3\text{CO} \longrightarrow 2\text{Fe} + 3\text{CO}_2$$
 - major silica impurities are removed as calcium silicate slag by addition of a fluxing agent limestone
 - the silicate slag is used in manufacturing cement.
23. Which of the following will act as an antacid?
- Sodium hydrogencarbonate
 - Magnesium hydroxide
 - Sodium carbonate
 - Aluminium carbonate

Integer / Numerical Value Type

24. What is the total number of iron atoms present in haematite and magnetite?
25. Find out the number of non-narcotic analgesics among the following :
 aspirin, ibuprofen, morphine, heroin, diclofenac sodium, paracetamol, codeine, naproxen.
26. The sweetness value of aspartame in comparison to cane sugar is _____ times.

Comprehension Type

Preservatives are the chemical substances which are added to food materials to prevent their spoilage and to retain their nutritive values for long periods, to prevent rancidity, to inhibit growth or kill the microorganisms.

27. Which of the following is used as a preservative to protect processed food?
- Sodium sulphate
 - Saccharin

- Sucralose
- Sodium metabisulphite

28. Butylated hydroxytoluene is used in a food material as
- an antioxidant
 - a colouring material
 - an artificial sweetener
 - a preservative.

Matrix Match Type

29. Match the column I with column II and select the correct option.

Column I		Column II	
P.	Iodoform	1.	Anaesthetic
Q.	Methyl salicylate	2.	Antiseptic
R.	Diethyl ether	3.	Insecticide
S.	Hexachlorocyclohexane	4.	Detergent
		5.	Pain balm

- | | | | | |
|-----|----------|----------|----------|----------|
| | P | Q | R | S |
| (a) | 2 | 5 | 3 | 4 |
| (b) | 4 | 2 | 1 | 3 |
| (c) | 2 | 5 | 1 | 3 |
| (d) | 3 | 1 | 4 | 2 |

30. Match the anionic species given in Column I that are present in the ore(s) given in Column II.

Column I		Column II	
(A)	Carbonate	(p)	Siderite
(B)	Sulphide	(q)	Malachite
(C)	Hydroxide	(r)	Bauxite
(D)	Oxide	(s)	Calamine
		(t)	Argentite

Select the correct answer from the options given below :

- | | | | | |
|-----|----------|----------|----------|----------|
| | A | B | C | D |
| (a) | p, q | s | p, r | s, t |
| (b) | q, r | p, s | q, t | p |
| (c) | r | r, s | s | q |
| (d) | p, q, s | t | q, r | r |



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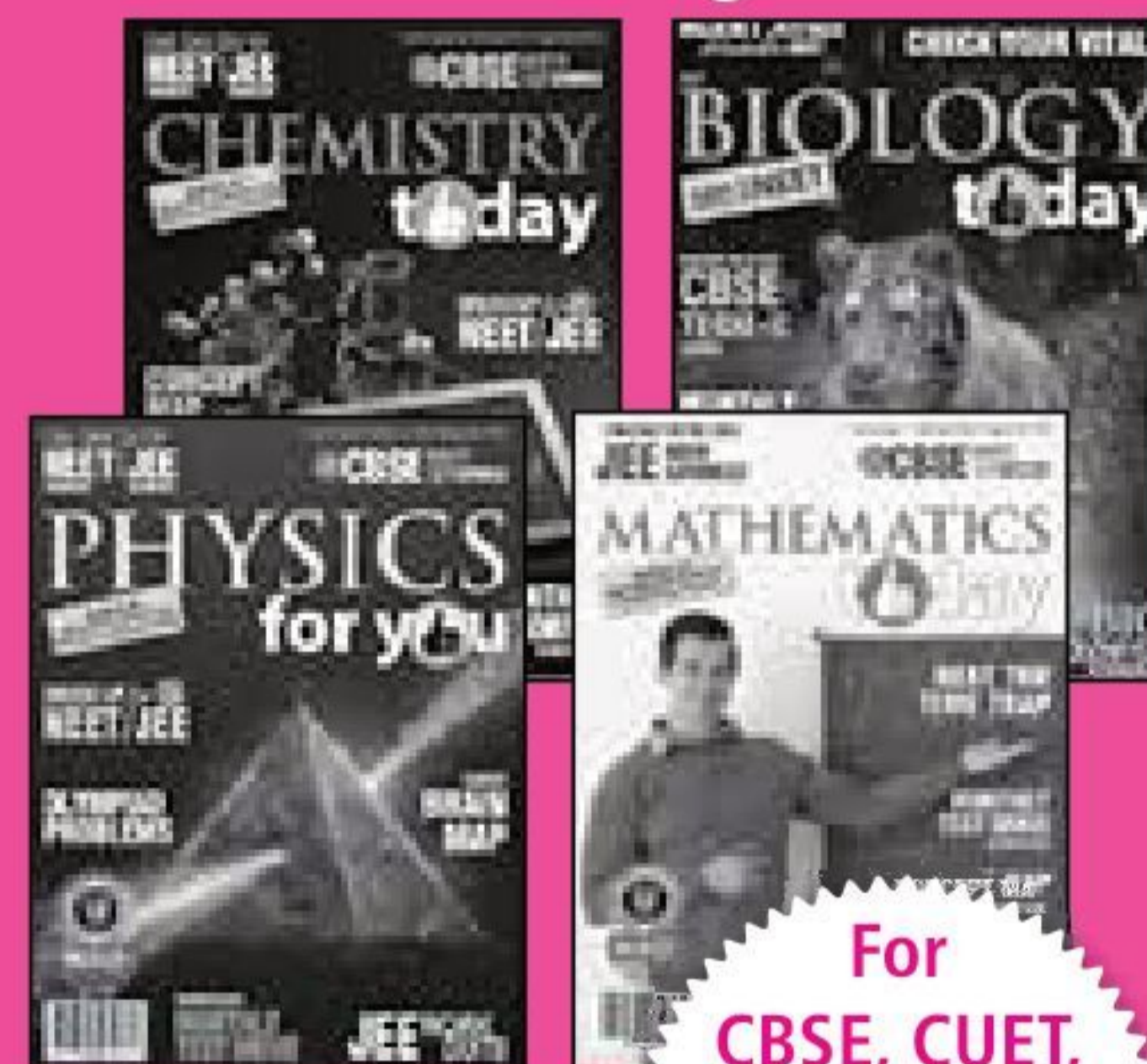


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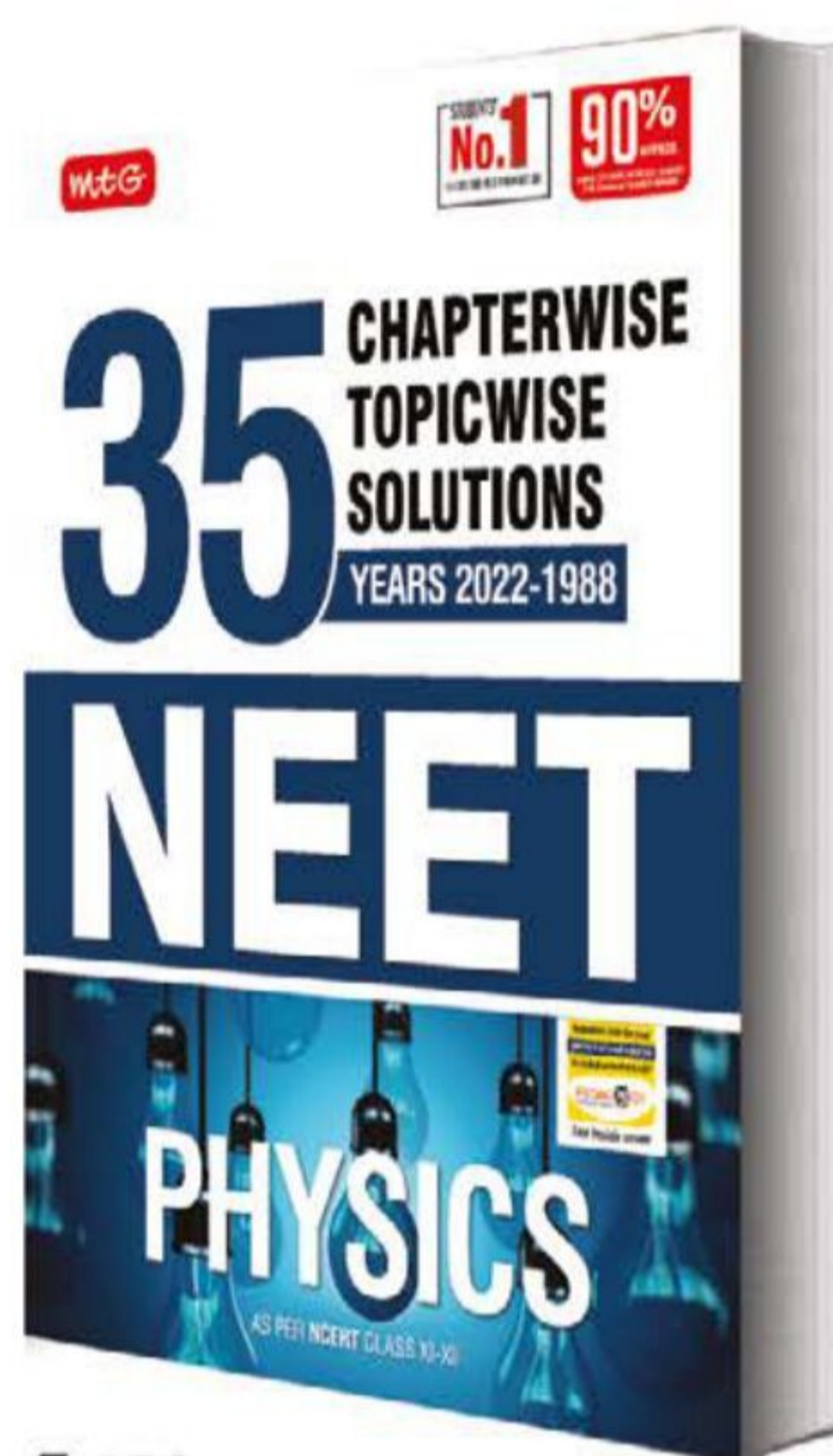


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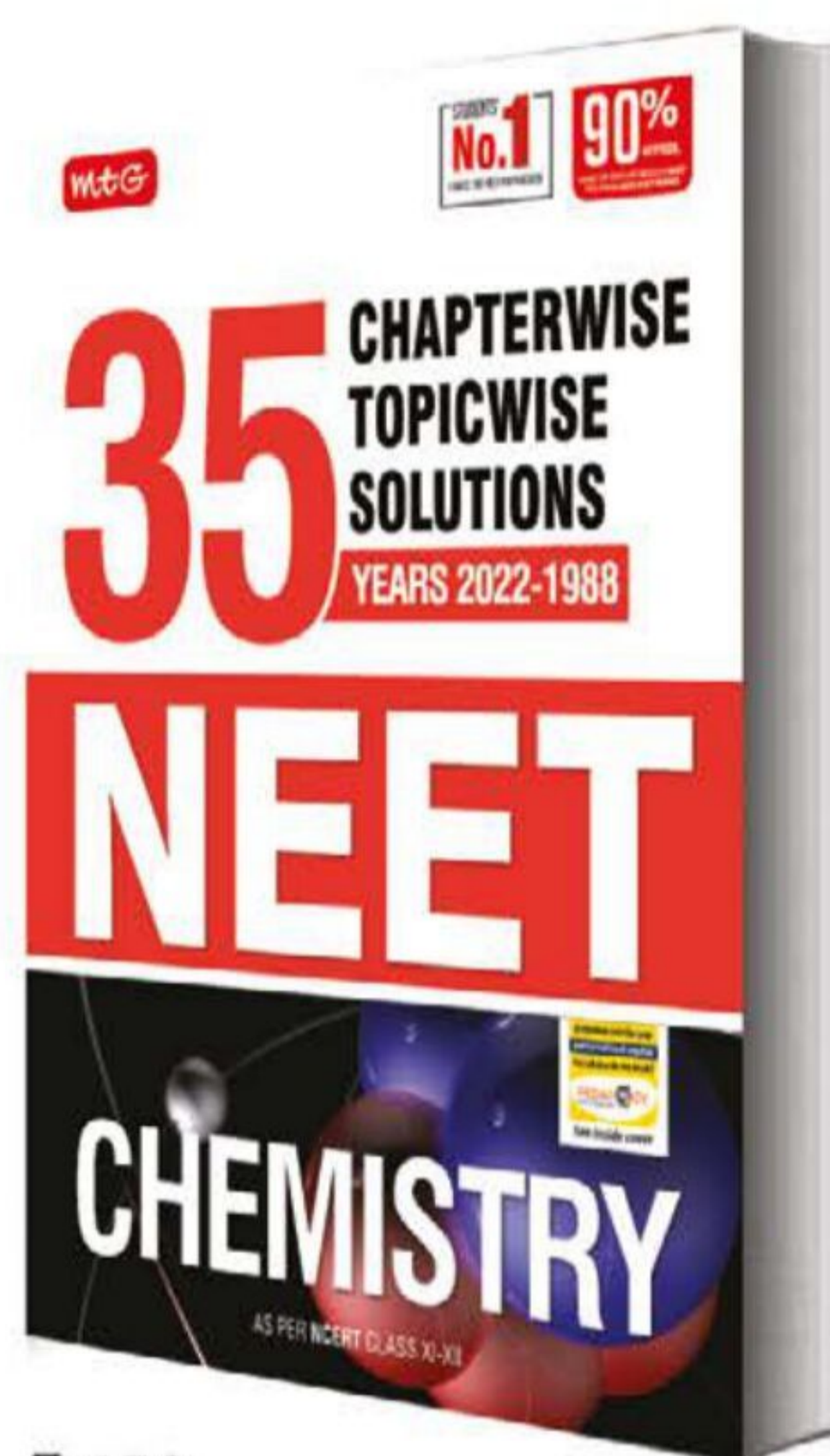
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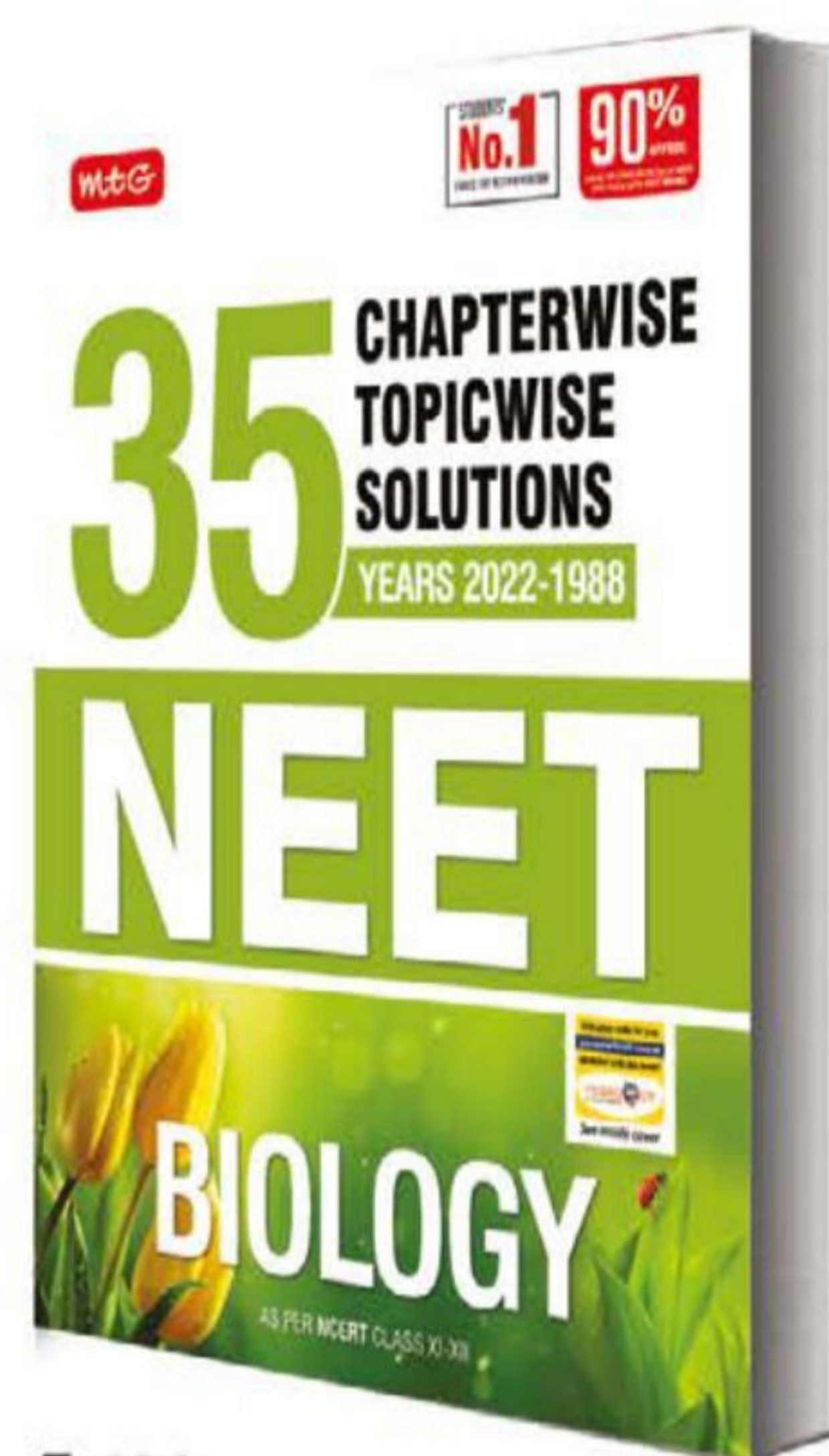
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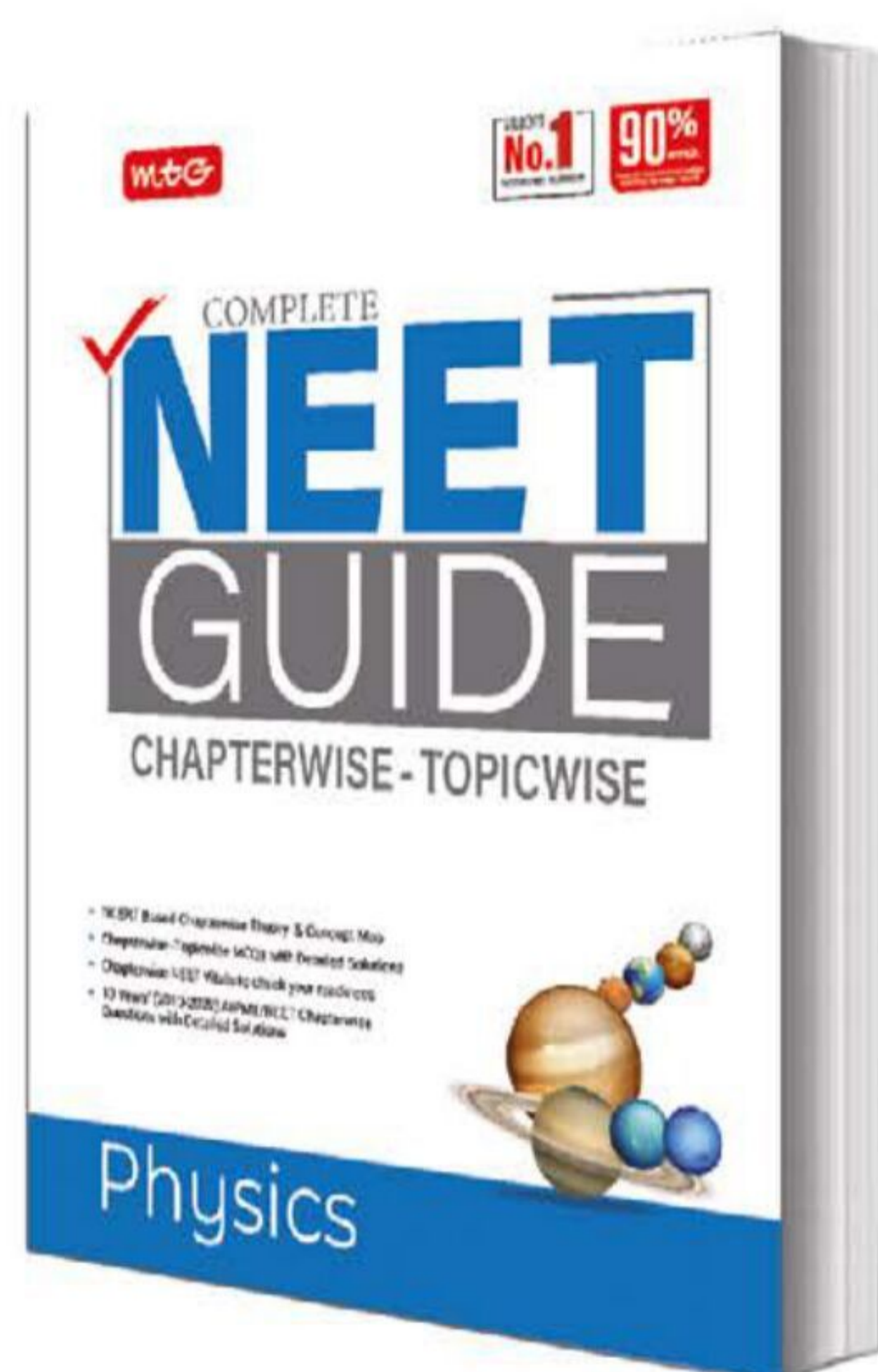
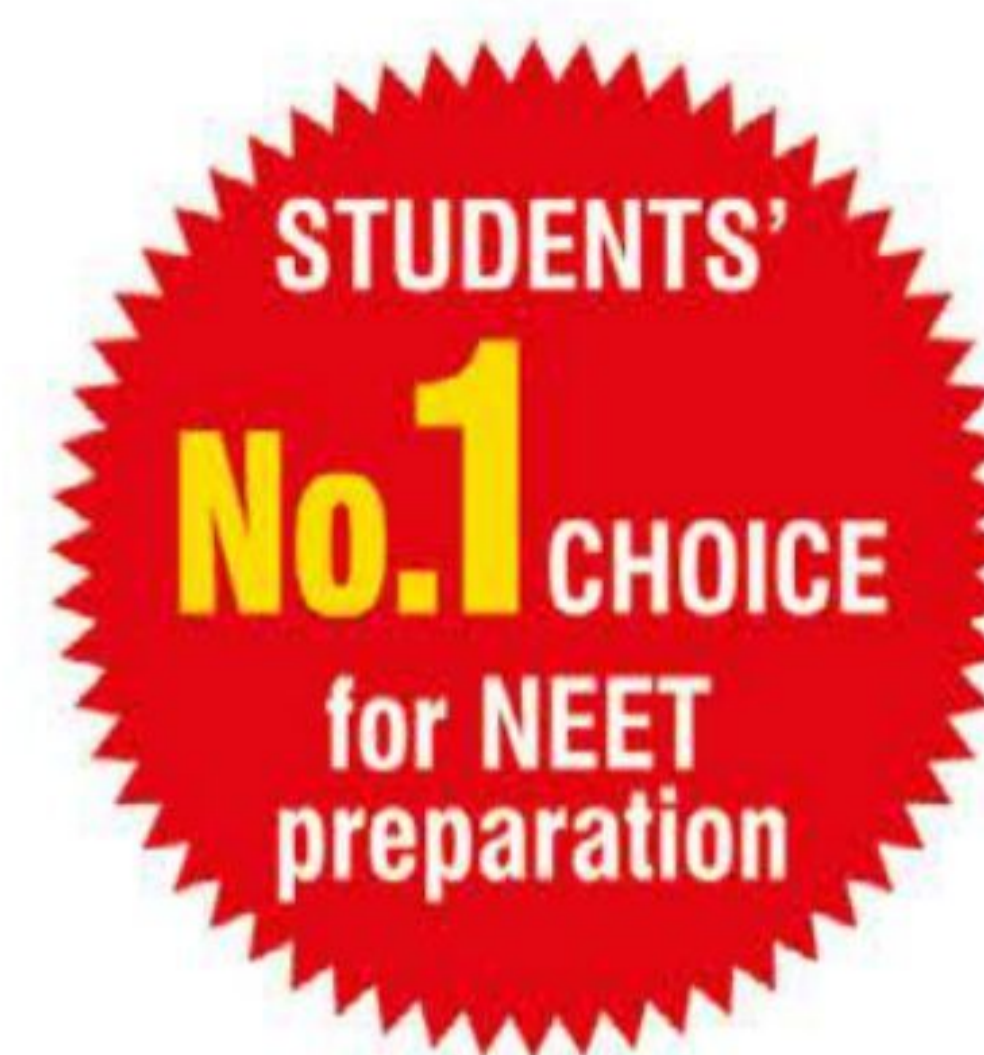
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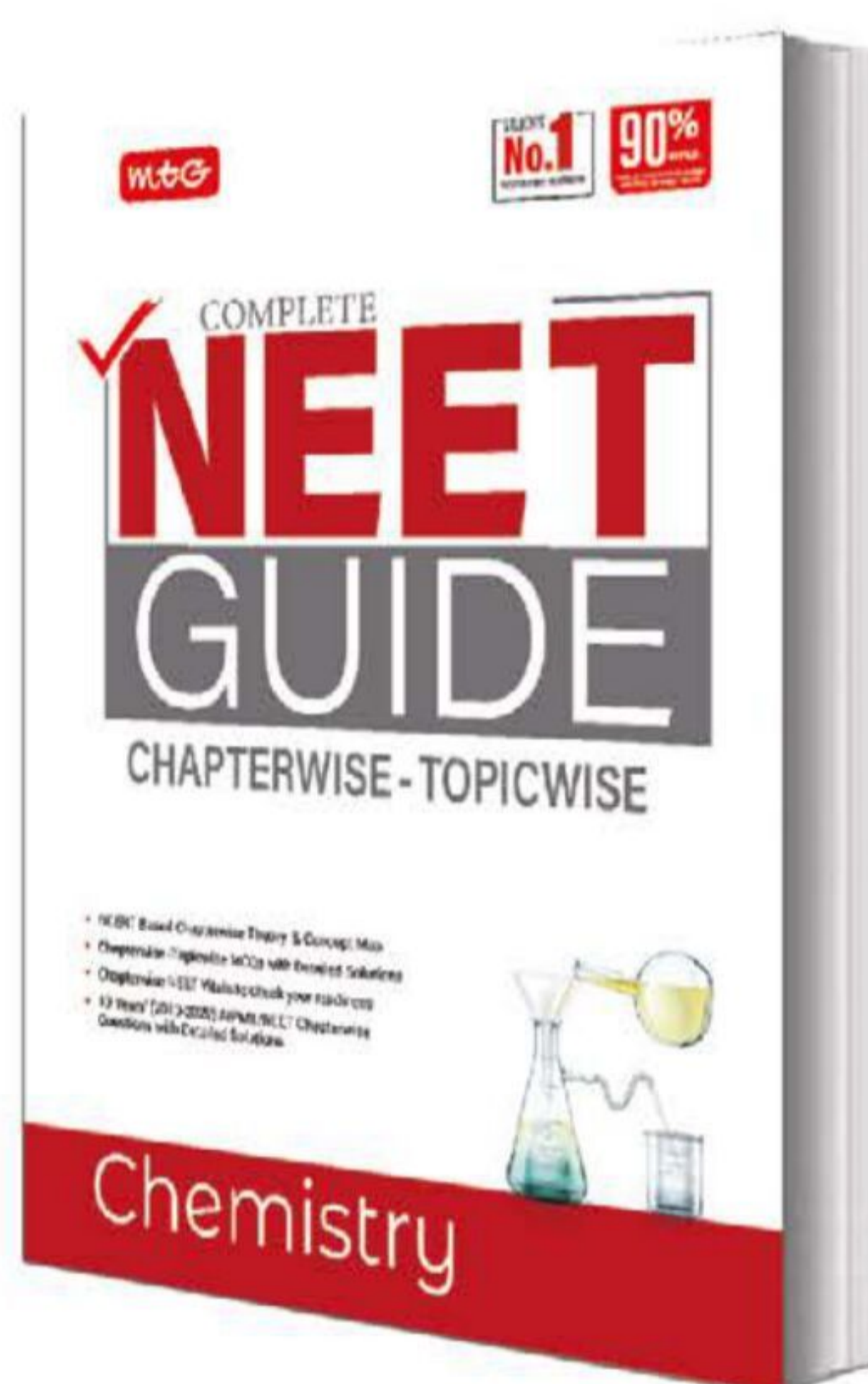
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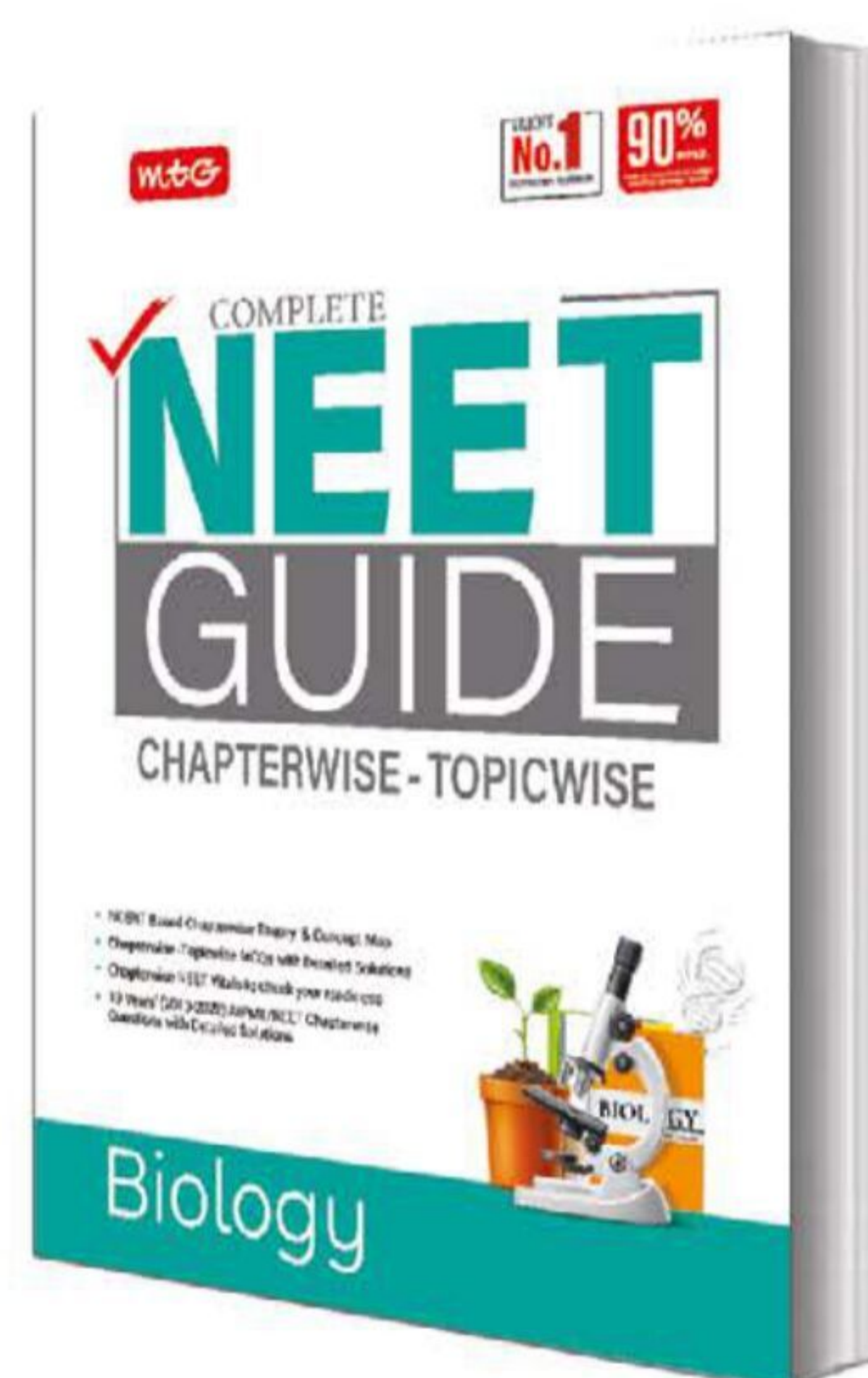
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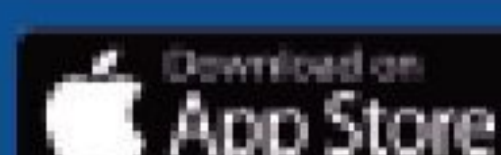


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